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Propelling Machinery for Collier Jupiter

BY WILLIAM L. R. EMMET

The serious development of large high-speed turbines for the generation of electricity began only about twelve years ago and has advanced with a wonderful rapidity. Reciprocating engines have been superseded in most of the important uses to which they were formerly applied. Rates of steam consumption have been greatly reduced and the designs of turbines themselves have been steadily improved and simplified. Th first turbines were of relatively low speed in proportion to their capacity, but the designing of the turbines and of the generators which they drive has steadily advanced the limits of size for a given speed, and this advance has conduced to simplification and great improvement of economy.

About five years ago the writer became convinced that these improvements of high-speed turbine generating units had attained a degree which justified their use in the propulsion of ships of certain classes—that is, that the superior efficiency and greater simplicity of the turbine were sufficient to offset the expense, weight, and losses incident to the use of electric generators and motors for the transmission of power. The advantages of electric drive are limited by conditions of capacity and of electrical frequency, and are most apparent in vessels requiring very large power and high rates of speed reduction, and particularly such vessels as require variable rates of speed reduction, as in the case of warships, in which it is necessary to make high speed and at the same time desirable to cruise economically at low speed.

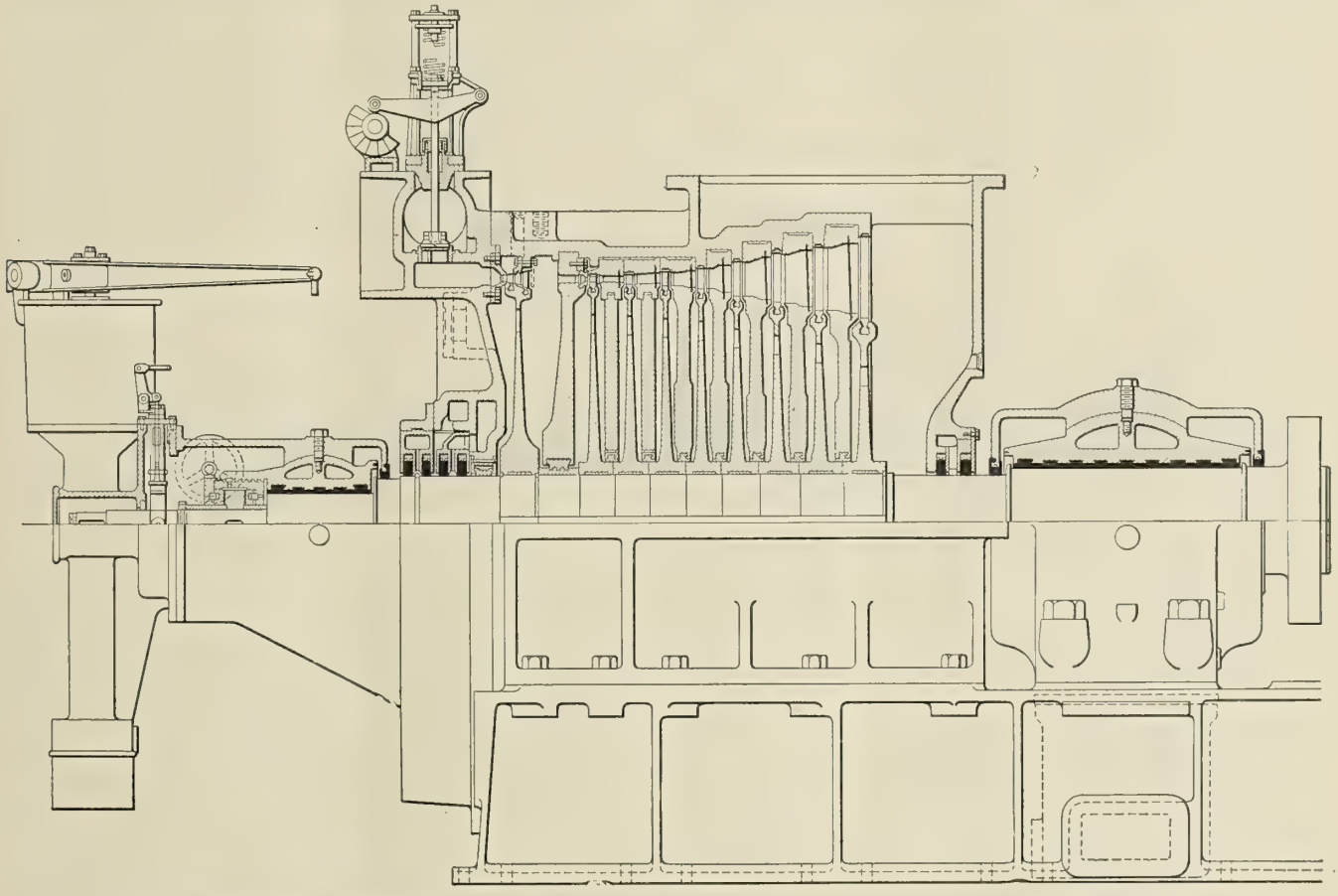


FIG. 1.—ASSEMBLY OF 5,000 KILOWATT HORIZONTAL HIGH PRESSURE 9-STAGE CURTIS TURBINE INSTALLED ON U. S. COLLIER JUPITER

Since electric propulsion was first seriously considered, the application of helical gearing to the same purpose has been proposed and successfully introduced on a very considerable scale. While the practical limits of speed reduction gearing are less definitely understood than those of electric transmission, it is the belief of the writer that gears have a very

large field of application in the propulsion of ships, and that electricity is preferable only in certain classes of vessels.

The *Jupiter* is one of the new United States Government colliers and is a sister ship to the *Neptune* and *Cyclops*. The

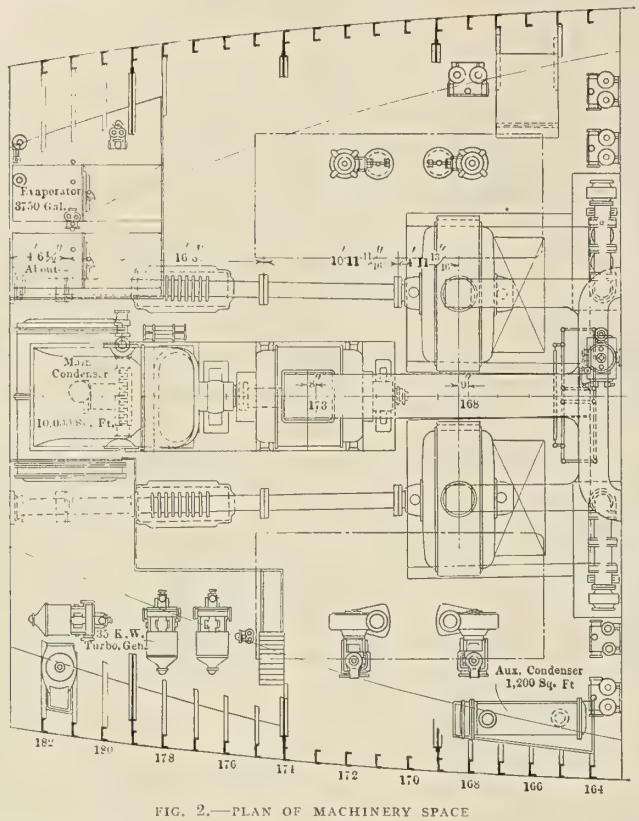


FIG. 2.—PLAN OF MACHINERY SPACE

Cyclops is equipped with reciprocating engines and the *Neptune* with a turbine drive connected to the propellers by gearing. These ships have a displacement of about 20,000 tons and carry something like 12,000 tons cargo. They are designed to operate at 14 knots. The *Cyclops* in her 48-hour trial averaged 14.6 knots, with a coal consumption for the main engines only of 1.485 pounds per indicated horsepower, the total indicated horsepower of both engines in this run being 6,705. The average speed of propellers was 92 revolutions per minute. The results of trials of the *Neptune* cannot be given here, but the fact has been published that her performance was not as good as that of the *Cyclops*, the difference being attributed to less efficient propellers and to inefficiency in the turbine. It is reported that the gearing works in an entirely satisfactory manner.

The following table shows comparisons of the known data concerning the equipments of these three vessels:

	Cyclops.	Jupiter.	Neptune.
Displacement, tons	20,000	20,000	20,000
Indicated horsepower at 14 knots.	5,600	....	....
Engine or turbine speed at 14 knots, revolutions per minute.	88	2,000	1,250
Propeller revolutions per minute at 14 knots	88	110	135
Weight driving machinery, tons.	280	156	....
Character, driving machinery	2 triple expansion engines.	1 turbo-generator and 2 motors.	2 turbines each with gearing.
Steam consumption in pounds per shaft horsepower per hour,	14 (estimated)	12 (tested)	.....
Speed maintained on 48 hours' trial, knots	14.6		13.9

While it is believed that the equipment of the collier *Jupiter* is very far superior in efficiency, lightness, and simplicity to anything which has previously been used in such a ship, it should be borne in mind that the vessel is not of a class in which electric propulsion affords its greatest measure of advantage, and its adoption by the government in the case of this ship was in the nature of an experiment to compare this method with other methods available.

Since this method was first proposed in connection with one of these government colliers, the rapid development of designs of high-speed turbines and of electrical apparatus has continued, and the engineering reasons for the use of electric propulsion have been materially strengthened. While the original turbine for the *Jupiter* was being built, a better and simpler method of design was developed, and this was subsequently applied in changing the design of the machine, which through this change was improved in efficiency nearly 10 per cent. The desired improvements, however, could only be partially applied within the limitations of time and space, and the machine as it stands is not up to the highest existing standards.

Within this time also, the needs of reversal in ships have been very carefully studied and certain developments in induction motor design have made possible the adoption for such purposes of motors of a simpler type than those used in the *Jupiter*. The equipment of this ship, therefore, although simple, practical, and efficient, is not up to the highest standard now attainable.

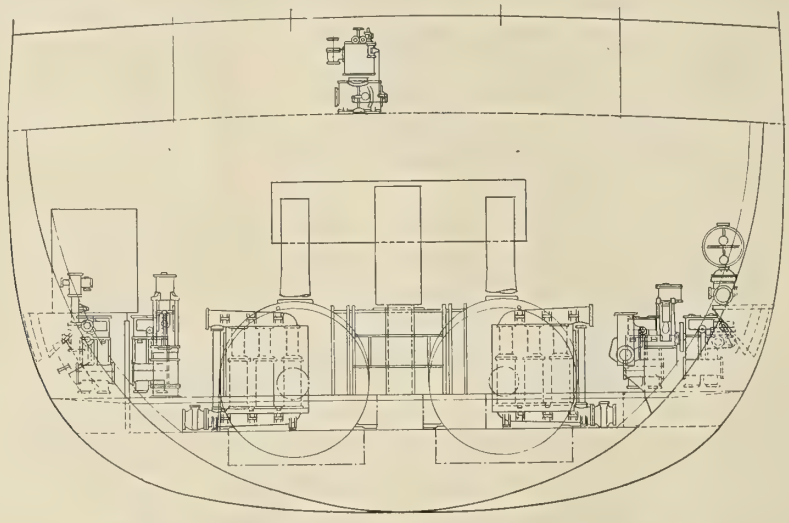


FIG. 3.—ELEVATION LOOKING FORWARD FROM FRAME 173 TO FRAME 163

The *Jupiter* is propelled by one turbine generating unit with an induction motor coupled to each of the propeller shafts. The generator is of the three-phase type, designed for about

FIG. 4.—ROTOR FOR MOTOR

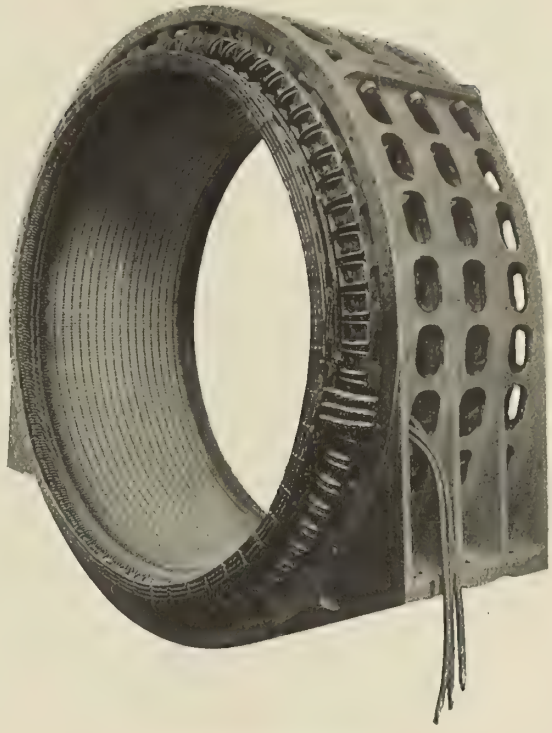


FIG. 6.—STATOR FOR MOTOR

5,000 kilowatts at about 2,300 volts. At 14 knots, which is the normal speed of the ship, it will run at about 2,000 revolutions per minute, and at this speed the motors will run at about 110 revolutions per minute, there being two poles in the generator and 36 poles in each of the motors. The ratio of speed reduction, disregarding slip of the motors, is 18 to 1.

The generating unit is quite similar in design and construction to such machines as are generally used on shore for electric lighting and power purposes. Its speed is controlled by a governor similar in construction to that used in turbo-generator units. This governor is different, however, in the respect that it is specially designed for adjustment through a wide range of speeds, so that by displacement of a fulcrum in the system of levers operated by the governor the turbine can be held at any speed from that corresponding to the highest

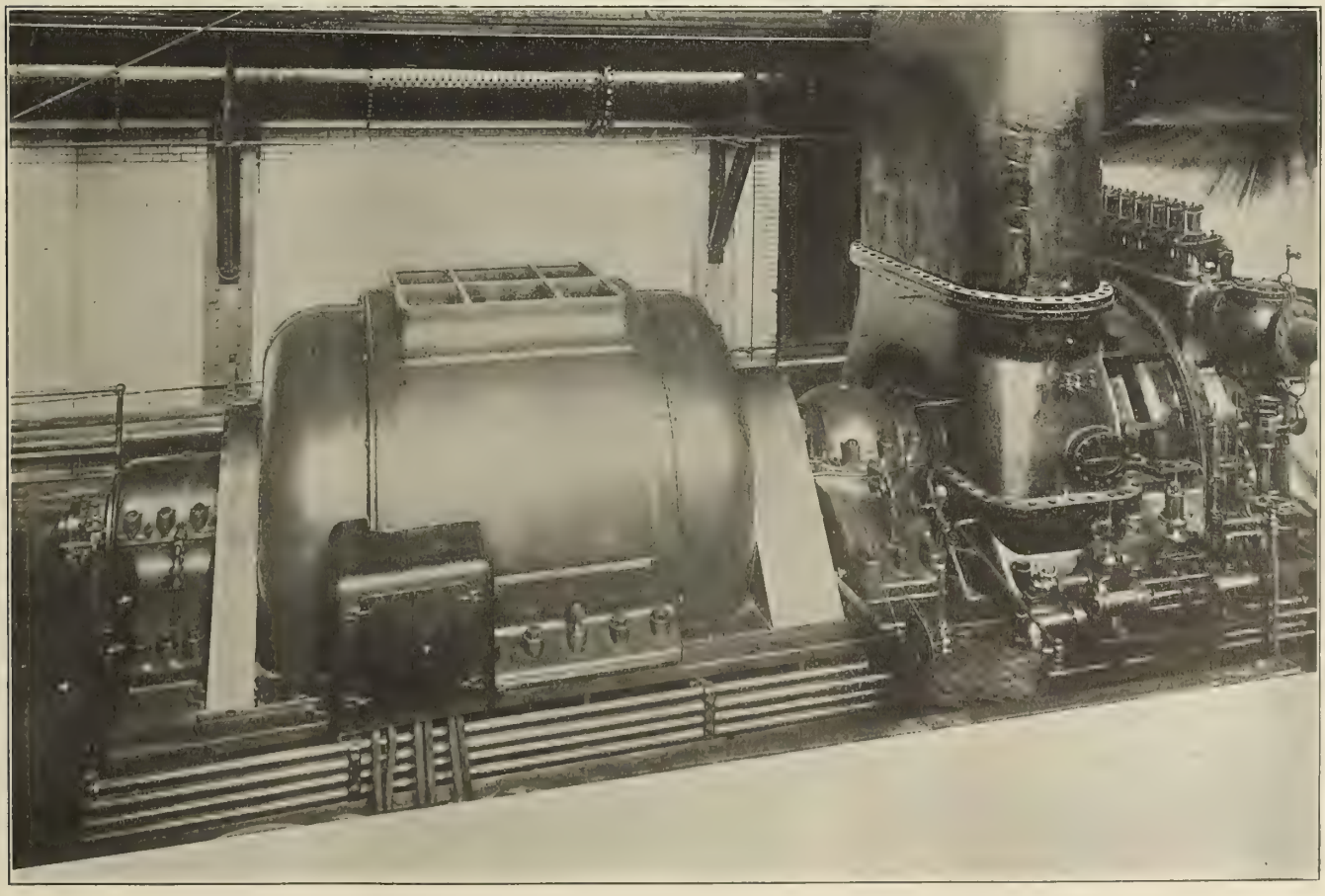


FIG. 5. TURBO-GENERATING UNIT, ASSEMBLED AT WORKS OF GENERAL ELECTRIC COMPANY FOR TEST

speed of the ship down to a speed corresponding to only 4 or 5 knots. The action of this governor opens and closes multiple admission valves on the turbine, and this means will ordinarily be used in controlling the speed of the ship. The speed is, however, independently controlled by a throttle valve in the main steam admission, and this throttle valve is designed to be tripped automatically at a speed slightly in excess of the maximum used, by a centrifugal device which is entirely

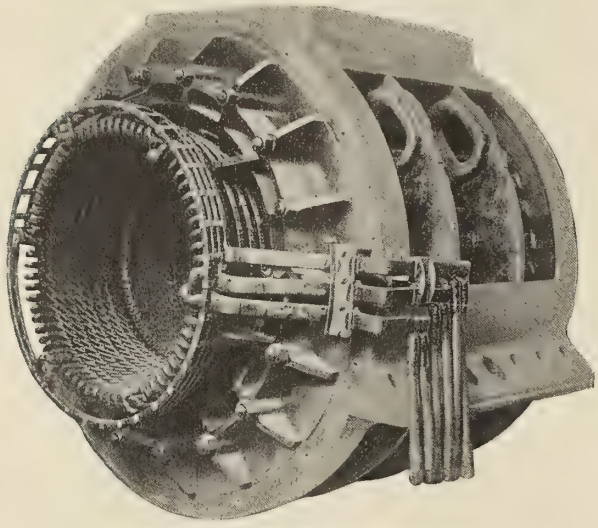


FIG. 7.—ARMATURE FOR GENERATING UNIT

independent of the governor mechanism. Thus while the governor affords a convenient and highly efficient method of control and speed variation, its presence in no way interferes with the operation of the turbine by throttle in the manner usually employed in the control of marine steam turbines. The speed of the governor is set from a dial controlling stand near the switchboard, which operates the mechanism through a simple system of bell cranks and rods below the floor. When the hand of this controlling dial is moved to a speed below that for which the governor is adjustable, such movement causes a complete closing of all the valves, so that this dial affords a means of positively shutting off the steam admission, which is entirely independent of the main throttle.

The governor is mounted on a vertical shaft, driven by a gear from the main shaft. On the lower end of this governor shaft a gear pump is mounted, which circulates oil through the bearings, and which also supplies oil to the hydraulic cylinder which governs the admission valves. An auxiliary steam pump is also mounted on the turbine base, which can be used for these purposes. The points where the shaft passes through the turbine shell are fitted with carbon ring packings made in segments and held together by garter springs. These are in separate compartments with chambers between them, and these chambers are either supplied with sealing steam or are connected to drains which extend to the low-pressure parts of the machine. The heat generated in the bearings is carried away by water, circulated in ducts provided for the purpose.

The turbine delivers steam to the condenser through an opening at the top and is fitted with drains by which water which condenses in its shells will pass by gravity to the hot well pump. The heat generated by losses in the iron and copper of the generator is carried away by currents of air induced by impellers attached to the ends of the rotor. The supply of air for this purpose is drawn from the space below the engine room floor and the heated air is discharged at the top of the generator. From this point it is conveyed by a sheet metal duct to a space forward of the engine room bulkhead, in which the Howden draft blowers are installed. The heated air from the motors is similarly conveyed, so that the heat lost from the electrical apparatus is returned to the furnaces.

The motors are of the three-phase induction type and have 36 poles. Their frames are of cast steel and are covered by sheet metal housings, which confine and carry away the heated air. Each motor is installed in a well surrounded by a combing, so that it cannot easily be filled by sea water. The windings are waterproof and not at all sensitive to wet. The motors would probably run successfully when partially submerged, but it would, of course, be better not to operate in this way. The pits afford a large amount of space below the level of the windings.

The rotor windings of motors are connected to collector rings which under nomal conditions of operation are short circuited by a slider on the shaft. These collector rings are connected through brushes to a water-cooled resistance through which a small amount of water is carried from the circulating pump. This resistance is provided for the purpose of affording a large torque in the operation of reversing. While this resistance is in circuit, the motor exerts a powerful torque, even when it is moving in a direction opposite to that of the generator, while without the resistance the motor torque only becomes high as it approaches a speed synchronous with that of the generator. When this resistance is in circuit, the current which flows through the motor is always limited and the motor can be switched on and off, stopped, started, and reversed with full voltage on the generator by simply pushing the switch handles in and out. When the vessel is being maneuvered in narrow waters where frequent

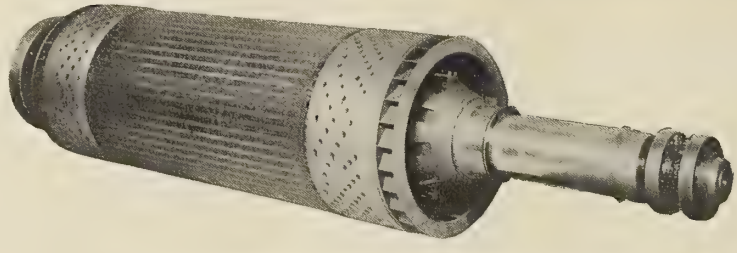


FIG. 8.—REVOLVING FIELD FOR GENERATING UNIT

reversals may be required, the resistance can be kept permanently in circuit as a matter of convenience in handling. Under this condition the vessel would be limited to about three-fourths speed and the operation would be less efficient than when running without resistance.

When the motors are operated without resistance, their speed is normally very nearly synchronous with that of the generator and their operation is highly efficient. If they were reversed in this condition they would draw a large current from the generator, but would produce a comparatively small torque on the propellers. It is therefore desirable, where prompt reversal is required, to cut the resistance in the motor circuit. This is done by levers attached to the motor frames, but it cannot be done while the circuit is alive. Reversal under such conditions is accomplished by first opening the field switch which de-energizes the circuit, then moving the levers

which cut in the resistances, then throwing the reversing switches, and lastly re-establishing the field circuit. These operations are quite simple and can be accomplished in a very few seconds, and locking devices are provided by which they cannot be accomplished in the wrong order. The resistance levers are secured by electric locks which do not admit their movement until after the field circuit has been de-energized. The reversing switches are interlocked with the ahead switches, so that both cannot be closed at the same time. Both the go-ahead and reversing switches are mechanically interlocked with the resistance levers, so that they cannot be closed while the motor resistance is cut out.

While the resistance with its accompanying mechanisms affords means of quick and very powerful reversal, it is not

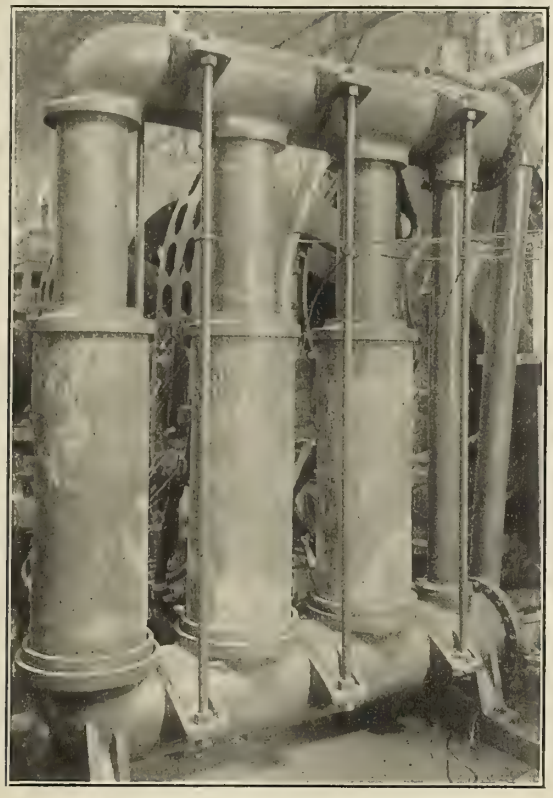


FIG. 9.—WATER-COOLED RHEOSTAT

essential to the reversal of the ship. The ship can be backed with a good power without the resistance by lowering the speed of the generator. Under such conditions the motors will bring the propellers to rest and start them in a reverse direction. Their speed will then increase until it is nearly synchronous with the reduced speed of the generator, after which the generator and motors can be brought up together with the full power available in the turbine.

The switchboard is fitted with four oil switches, one for going ahead and one for reversing on each motor. It is also provided with switches which open the field circuit of the generator and the field circuit of the exciter. It is also provided with instruments which show the current in the circuit of each motor, the voltage at the generator terminals, the power delivered to each motor in watts, and the speed of the generator as indicated by the electrical frequency. The switchboard is also fitted on its base with integrating watt hour meters which record on dials the total power which the motors consume.

The excitation of the turbine driven alternator is provided by any one of three turbine-driven direct current generating units which can be used either for this purpose or for delivering lighting and power for the ship. This group of units is provided with a switchboard with arrangements by which any one of them can be set apart as an exciter for the propelling machinery. When connected for this purpose, its voltage is controllable by a rheostat on the propelling switchboard and its circuit can be opened by a suitable switch provided on that board. The degree of excitation required on the main generator depends upon the amount of power required, and the most economical condition of operation will generally correspond to the lowest exciting voltage which can be used at such speed. The exciting voltage required under each condition of speed will be shown by experience. If this voltage is reduced too low, the motor will fall away from synchronism, which will be shown by a sudden rise in its current. Under such conditions it can be restored to synchronism by simply lowering the generator speed and slightly increasing the exciting voltage so that it will hold at the speed desired.

Launch from the Harbor Dockyard

On Monday, July 7, Messrs. Irvines' Shipbuilding & Dry Docks Company, Ltd., launched from the Harbor Dockyard, West Hartlepool, the steel screw steamer *Eustace,* built for Messrs. The Pyman Steamship Company, Ltd., West Hartlepool (Messrs. George Pyman & Company, managers). The dimensions of the vessel are 387 feet by 51 feet 3 inches by 26 feet 10 inches depth, molded, carrying over 7,400 tons on a moderate draft. She is built to Lloyd's highest class on the shelter deck principle, having two complete steel decks, and water ballast is carried in the cellular double bottom and fore and after peaks. The vessel is constructed with deep frames without side stringers, giving exceptionally clear holds for the stowage of bulky cargoes. Wood grain divisions are fitted throughout the holds to Board of Trade requirements, and the steamer is divided into seven watertight compartments by six transverse bulkheads. Large hatches are provided, together with the latest facilities for the rapid loading and discharging of cargo, including ten powerful steam winches exhausting into a winch condenser, and ten derricks. A powerful quick-warping steam windlass is fitted forward, with steam steering gear amidships and hand gear aft. Triple expansion engines will be supplied and fitted by Messrs. Blair & Company, Ltd., Stockton-on-Tees, having cylinders 25 inches, 42 inches and 68 inches by 48 inches, with two large single-ended boilers and one auxiliary boiler, all connected up to the main engines, and furnishing steam at 180 pounds pressure.

The Year's Shipbuilding in the United States

During the year ended June 30, 1913, there were built in the United States 1,648 vessels, of 382,304 gross tons, officially numbered by the Bureau of Navigation, which, compared with 1,720 vessels of 243,792 gross tons for the same period of 1911-1912, shows a gain of 138,512 gross tons, or 57 percent. This is the largest construction in the United States since 1908. Of the total tonnage constructed, 225,467 gross tons, or 59 percent, were steel steamships, of which 62 percent was built on the Atlantic and Gulf coasts, 30 percent on the Great Lakes, and 8 percent on the Pacific coast. The most important part of the shipbuilding industry is the construction of steel steamships, and in this respect the shipyards on the Atlantic coast showed the greatest activity. Here 58 steel steamships, aggregating 138,617 gross tons, were built, as compared with 33, aggregating 39,682 tons a year ago, or an increase of 250 percent. On the Pacific coast there was an increase of 380 percent in the construction of steel steamships, 16, aggregating 17,533 gross tons, being built last year, as compared with 10, aggregating 3,658 gross tons, for the year before. On the Great Lakes, however, there was a decrease of 14 percent in the construction of steel steamships.

French Battleships Provence and Bretagne

The French battleships *Provence* and *Bretagne* were launched by the Lorient and Brest Dockyards on April 20 and 21, respectively. The keel of the *Provence* was laid May 1, 1912, and that of the *Bretagne* July 22, 1912. Both battleships were launched according to the French dockyard practice; that is, with only a single sliding way directly under the keel. The launching weight of the *Provence* amounted to 8,400 tons, including the cradle. The sliding way was 498 feet long, 48 inches wide and 16 inches thick, the declivity of the ways being 8.06 percent. The launching weight of the *Bretagne* was 8,300 tons, the sliding way in this case being only 443 feet long, 48 inches wide and 22 inches thick, with a declivity of only 6 percent. Both launches were successfully carried out.

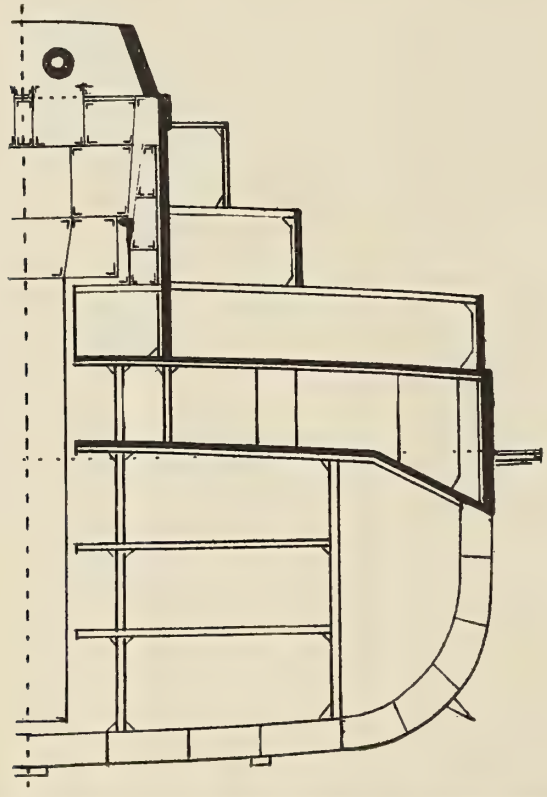


FIG. 1.—SECTION OF BATTLESHIP BRETAGNE AT FORWARD TURRET

The main particulars of these vessels are: Length over all, 545 feet; beam, extreme, 88 feet; draft, forward, 27 feet 11 inches; aft, 29 feet 3 inches; area of 'midship section below load-waterline, 2,752 square feet; displacement at normal draft, 23,546 tons; brake horsepower, estimated, 28,000; speed, estimated, 20 knots.

From the double bottom (which extends up the sides to the lower protective deck) to the spar deck there are two twin decks—the lower protective deck, the upper protective deck, the gun deck and the spar deck.

Armor

The ship is protected by a belt of armor extending from stem to stern and from a distance 5 feet 7 inches below the load-waterline to a height of 7 feet 9 inches above the load-waterline. The main belt of armor is 11 inches thick between the forward and after turrets and 7 inches thick to the stem and stern. Behind all the armor there is a backing of 3-inch teak.

For a length of about 197 feet from turret No. 1 to the after funnel, extending from the upper edge of the main armor below to the spar deck, there is an armored citadel protected by 7-inch armor. At both the forward and after ends of the citadel there are 'thwartship armored bulkheads of the same thickness. The secondary armament, the base of the funnels, the conning tower and turret No. 5 are, therefore, well protected. On both sides of turrets Nos. 4 and 5 are casemates for the secondary armament, similarly protected. At a point aft, not far from the stern, there is a cross-bulkhead of 7-inch armor connecting the two sides of the armor belt.

There are two protective decks; the lower one of 1⅝-inch plates on the flat and 2¾-inch plates on the slopes, the upper one of 1¾-inch plating throughout. The lower protective deck extends from the lower edge of the main armor belt; that is, 5 feet 7 inches below the load-waterline at the wings, and is at about the level of the load-waterline at the center line. The upper protective deck extends from end to end of the ship at the level of the upper edge of the main armor belt. The central part of the ship—that is, the space between the two protective decks— is encased by armor, and is divided as follows: From the outside, armor plate, a cofferdam, a passage, two store or bunker rooms, another passage, a storeroom and the central passage.

Below the lower protective deck the hull is divided into a number of main watertight compartments by transverse bulkheads connected with at least one or two longitudinal bulkheads. Each of these main compartments is again subdivided into several smaller ones. The thickness of the bulkhead plating is graduated in order to provide sufficient strength in case one compartment is flooded up to the level of the lower protective deck.

In order to insure greater safety, each of the main engine and auxiliary compartments is formed by solid bulkheads without watertight doors, access to these compartments being obtained by special entrances from the deck above.

According to the practice of the French navy the ship is equipped with only a single rudder, and that of the balanced type, the framing being of cast steel.

Machinery

Steam is supplied by two groups of boilers, each group having a single funnel. The first group is divided into three boiler rooms, while the second group is all contained in a single boiler room. The boilers are designed so that they can be fired with either coal or liquid fuel. The boilers of the *Bretagne* were supplied by Messrs. Niclausse, while the boilers for the *Provence* were built by the Navy Works, Indret. The main features of these boilers are:

Bretagne

Number of boilers	24
Total grate surface	2,090 square feet
Total heating surface	64,660 square feet
Steam pressure	256 pounds
Tubes:	
Number of elements	380
Number of tubes	9,784
Length	7 feet 10 inches
Outside diameter	3 5/16 inches
Inside diameter	3 inches
Area of section of forward funnel	148 square feet
Area of section of after funnel	76 square feet
Height of funnels above the load-waterline	66 feet

Provence

Type of boilers	Guyot du Temple
Number of boilers	18
Total grate surface	1,492 square feet
Total heating surface	62,585 square feet
Steam pressure	256 pounds
Tubes:	
Inside diameter	1 3/16 inches
Outside diameter	1 7/16 inches
Height of funnels above grate bars	96 feet 5 inches

Coal consumption allowed per contract, 10-hour full power trial, 2,700 pounds per mile. Three-hour full power trial, forced draft, 321 pounds per square foot of grate area, pressure in boiler rooms 1 inch of water. Twenty-four hour trial under normal draft, 1,853 pounds per mile. Consumption trial, with one-half boilers at work, 1,168 pounds per mile.

Under ordinary circumstances 900 tons of coal are to be carried, but there is ample room for carrying 2,700 tons, and with this amount of fuel the ships will have a theoretical cruising radius of 8,500 miles at a speed of 10 knots, and a range of 2,500 miles under full speed (20 knots).

Both battleships are engined with Parsons turbines, those for the *Bretagne* being supplied by the Forges & Chantiers de la Mediterranée, and those for the *Provence* by the Ateliers & Chantiers de la Loire. In each case the turbines drive four shafts, although the arrangement is different from that in the *Voltaire* class. In these ships there are no cruising turbines, and this enables the designers to divide the turbines into two separate and independent sets—the starboard and the port sets. The high-pressure turbines are mounted on the wing shafts and the low-pressure turbines on the inner shafts. The impulse sections of the high-pressure turbines consist of four wheels for ahead working and two wheels for the astern turbines. The wheels have a mean diameter of 11 feet 2 inches, each being divided into four stages. Admission of steam is regulated by a number of nozzles at the impulse end, and the number of nozzles set at work regulates the speed of the turbines and gives good economy at low speeds, without the necessity of installing cruising turbines. These turbine installations are designed to develop 28,000 brake horsepower when running at 300 revolutions per minute to give the ships a speed of 20 knots.

The main condensers are located aft of the low pressure turbines in two watertight compartments, the cooling surface is 32,000 square feet, and they have been designed for condensing the full quantity of exhaust steam when the engines are running at full speed and maintaining a vacuum of 27.6 inches with cooling water at 15 degrees C.

The auxiliaries, such as capstans, windlasses, etc., which require large power, are actuated by steam, while all others are driven by electric motors. The electric plant consists of four dynamos, each of 200 kilowatts capacity. Fore-and-aft near the turrets are two other similar generating sets for supplying electricity for operating the turrets. The total electric power on board the vessels amounts to 1,650 horsepower.

The ammunition rooms are ventilated by electrically-driven fans, which are so designed that by the use of the fans alone the maximum temperature of 25 degrees C. will not be exceeded. In order to obtain a lower temperature a special refrigerating plant has been provided, consisting of three sets of Westinghouse-Leblanc apparatus.

ARMAMENT

The *Provence* and *Bretagne* are the first French battleships to be equipped with armament heavier than the usual 12-inch guns. The main battery consists of ten 13.5-inch guns, located in five turrets, all on the centerline of the vessel—two forward, two aft and one about 'midships. The turrets are protected by 13.5-inch plates on the front, 10-inch plates on the sides and 11-inch plates at the base. The respective heights of the turrets above the load-waterline are: Turret No. 1, 30 feet 6 inches; No. 2, 37 feet 9 inches; No. 3, 33 feet 6 inches; No. 4, 28 feet 7 inches, and No. 5, 21 feet 4 inches. Turrets Nos. 1 and 5 have an arc of fire of 135 degrees; Nos. 2 and 4, 140 degrees, and No. 3, 120 degrees on each side. The fore-and-aft fire consists of four 13.5-inch guns, while all the guns can be used on either broadside. It is reported that the 13.5-inch guns are about 67 feet in length; weigh 66 tons each, and throw a shell weighing 1,190 pounds.

The secondary armament consists of twenty-two 5.5-inch guns, placed in five groups on each side of the ship. These guns have an arc of fire of 120 degrees, and throw a shell weighing 80 pounds. The guns located in the main citadel are 19 feet above the load-waterline and, in the after casemates, 12 feet above the load-waterline.

The armament also includes four 18-inch torpedo tubes, located two forward and two aft.

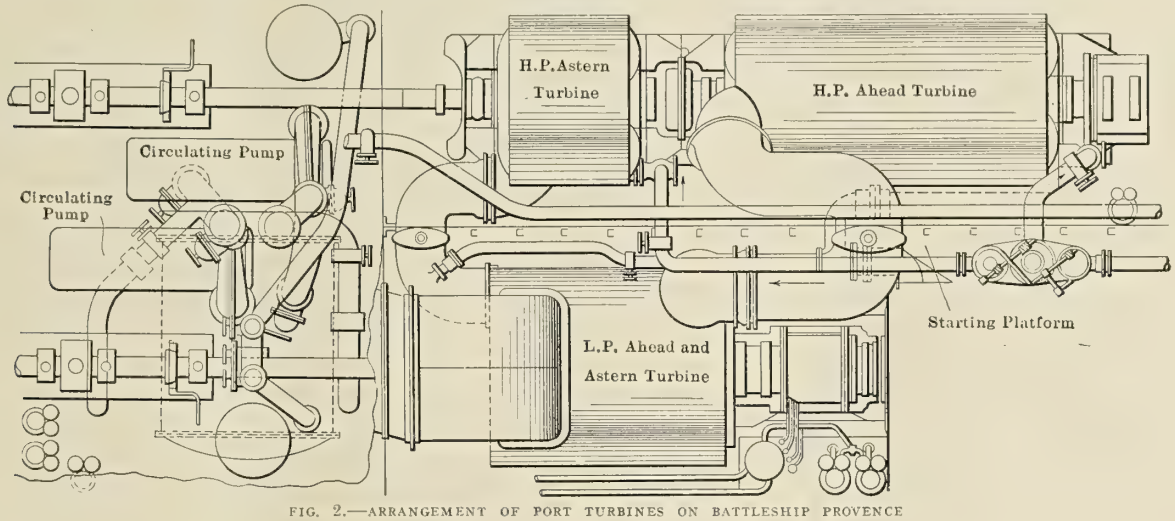


FIG. 2.—ARRANGEMENT OF PORT TURBINES ON BATTLESHIP PROVENCE

Lloyd's Register Shipbuilding Returns.—The returns compiled by Lloyd's Register of Shipping, which only take into account vessels the construction of which has actually begun, show that, excluding warships, there were 543 vessels of 2,003,241 tons gross under construction in the United Kingdom at the close of the quarter ended June 30. The tonnage now under construction is 60,000 tons less than that which was in hand at the end of the last quarter, but exceeds by about 229,000 tons the tonnage building in June, 1912.

Rebuilding a Double Bottom Under Engines

BY ENRICO BENVENUTI

A very important piece of repair work, which is rarely undertaken in marine engineering, was carried out recently in a special manner in Genoa harbor. One of the larger Italian mail steamers, built in 1908, and owned by one of the most important Italian steamship companies, for some time gave trouble on account of imperfect workmanship on the double-bottom plating under the main engines.

The trouble first began by frequent breaking of the holding-down bolts of the engines; but as no further danger was evident, and as the bolts which gave trouble were not fitted in the bedplate holes, it was believed to be a question of unequal bolt strains, consequently the bolts were replaced by other bolts of greater diameter which fitted well in the bolt holes.

This repair proved satisfactory during one or two transatlantic voyages, but after that a much more serious trouble became evident. The riveting of the double bottom plating began to loosen and the double bottom began to leak. Owing to the unsteadiness of the plating the engines themselves became unsteady, with the serious possibility of breaking the main steam pipes between the after bulkhead and the high-pressure valve chests. The necessity of undertaking the general reconstruction of the double bottom plating under the main engines was therefore decided upon.

The original construction of the double bottom of the ship in the engine room was as shown in Fig. 1. There was a center keelson and five side keelsons on each side, and two margin plates with double angles securing all these members to the plating. The plates and angles of the keelsons, etc., were all of more than sufficient scantlings for the design. The double bottom plating, however, was as shown in Fig. 1. There were four main plates, *A, B, C* and *D*, 30 feet by 7 feet by 1 inch thick under the engine bedplates, while the remaining plates in the double bottom, *a, b* and *c*, were only ½ inch thick.

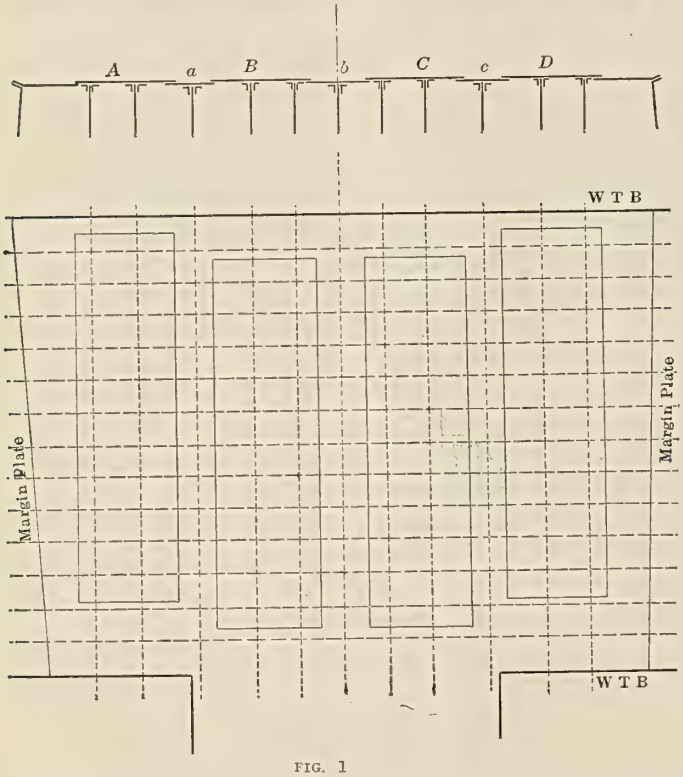


FIG. 1

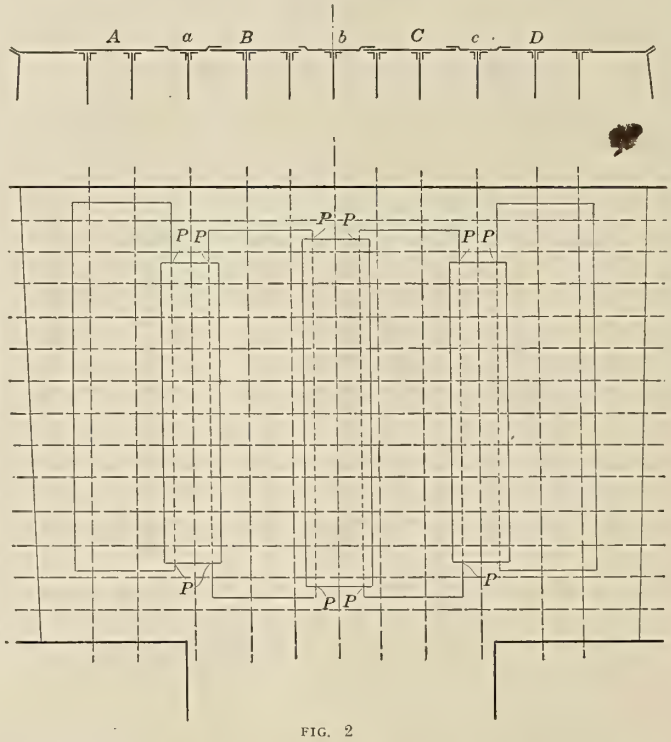


FIG. 2

After a complete examination of the structure the technical staff of the steamship company and the surveyors of the Italian Register agreed upon the necessity of carrying out the following work:

Complete disconnection of the double bottom plating, the substitution of 1-inch plates for the ½-inch plates in the double bottom, the new plates to be joggled riveted upon the four main 1-inch plates already in the double bottom, as shown in Fig. 2, the drilling of all the rivet holes, and re-riveting the double bottom with 1⅛-inch rivets. The new plates to be put in were 27 feet long by 3 feet 7 inches wide.

The two triple-expansion engines, each of 3,800 indicated horsepower at 83 revolutions per minute, had bedplates 24 feet by 14 feet 6 inches, and were 26 feet high to the cylinder covers. Owing to the short time available the technical staff of the company resolved not to unship the engines, or to dismantle any part of them. The repairs were carried out as follows:

First the starting platform and some of the lower gratings were removed, the engines were detached from the water and steam piping, and all the holding-down bolts were removed, and the high-pressure crankshafts were turned over 180 degrees, so as to have the three crankshafts of each engine placed as in Fig. 4. Two wooden guides were then placed between the cylinders of each engine, and the side wall of the engine room casing and wooden slippers were fixed to the cylinders, as indicated in Fig. 3. Also two differential blocks were attached to the top of each engine.

Below each crankshaft a hydraulic jack of 150 tons' capacity was placed, as shown in Fig. 4. The hydraulic pumps were located between the engine, and their manometers were placed in a conspicuous place near the pumps. One engine at a time was then raised.

During the raising the hydraulic rams were worked with gradually-increasing strains from the high-pressure to the

low-pressure end of the engines, and the whole weight of each engine was found to be about 200 tons. As the engine was jacked up double wooden blocks were placed below each column, and the differential blocks fastened to the top of the engine were kept under tension.

After each lift of 8 inches the hydraulic rams were replaced at the starting point of their stroke, and in this manner the two engines were lifted 3 feet above the double bottom plating.

The disconnection of the plating was then undertaken by means of oxy-acetylene apparatus, and the three plates, *a, b, c,*

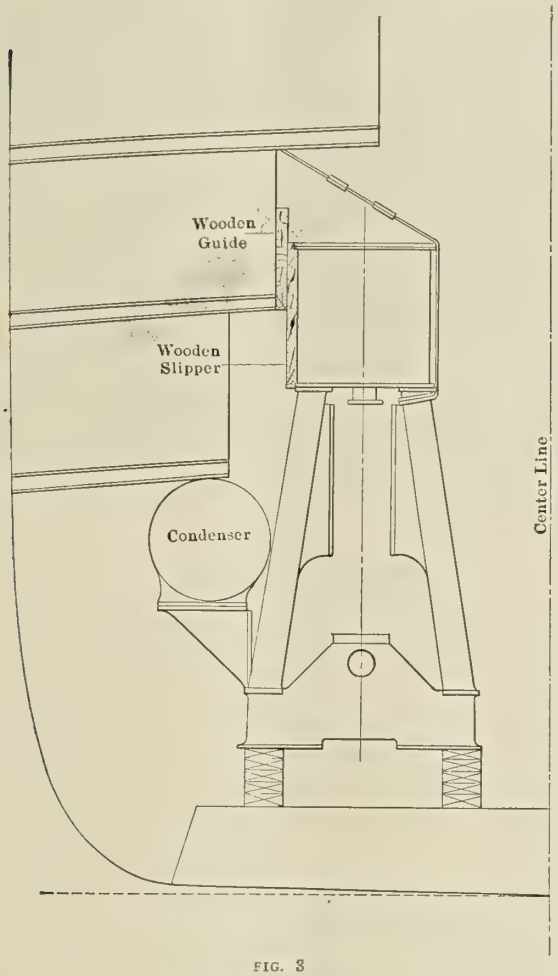


FIG. 3

Figs. 1 and 2, which were to be changed, were cut into several pieces by the oxy-acetylene apparatus and then taken out.

A disagreeable surprise was experienced at this time, as the countersinking of the double rows of rivets on the edges of the main plates, upon which the engines were seated, had been so badly done by the builders of the ship that it was impossible to drill them for riveting to the new joggled 1-inch plates.

This difficulty was overcome by brazing some iron inside each hole with the oxy-acetylene apparatus and reducing its diameter to about 5/8 inch. This method succeeded very well and required only about four days' time for completing 1,000 holes. After this was accomplished the holes were enlarged to 1 inch diameter by means of pneumatic drills, and three wooden templates, carefully worked, were built in place for the new joggled plates. During the time these plates were being finished at the shop, the pneumatic drilling and hand-riveting of the plates which were not to be renewed was accomplished on board the ship.

Taking away in turn one or the other of the two blocks placed below each cylinder column, it was possible to carry out all the riveting of the double bottom just as if the blocks were not there. Each block remained disengaged by forcing in the two tapered wooden pieces of its sister block.

The work of putting in place under each engine one of the 27-foot by 3-foot 7-inch by 1-inch plates was carried out as follows:

The plate was laid on the double bottom plating between the two engines, the three hydraulic jacks were again put in place under the crankshafts, and the six front blocks on which the engine was supported were temporarily removed. Having taken care to reduce to a minimum the transverse breadth of the base of each hydraulic jack, it was possible after the new

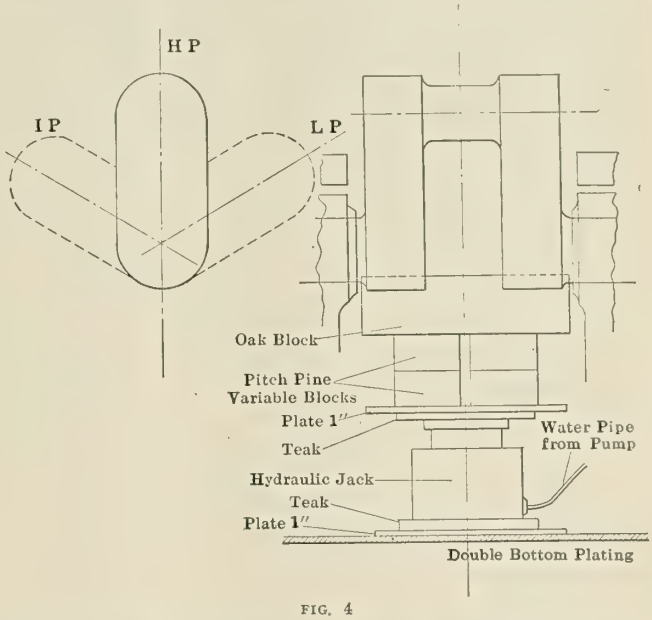


FIG. 4

plate was rolled under the engine to put the front blocks in place again, as shown in Fig. 5, and then by removing the jacks the plate could be put in its proper location.

After repeating this work for the two engines the new center plate was put in place, for which no special work was required. The holes in the plates, which had been punched in the shop 7/8 inch diameter, were enlarged to 1 1/8 inches diam-

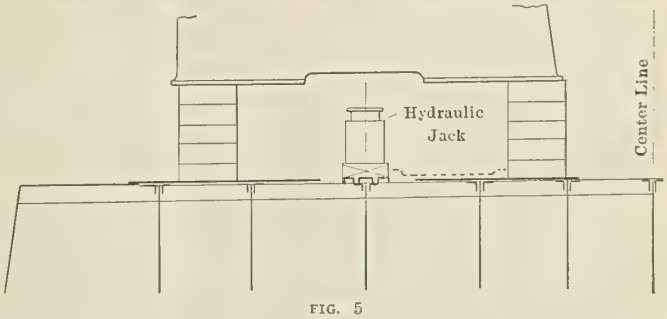


FIG. 5

eter by pneumatic tools, as all the riveting was to be done by hand with 1 1/8-inch rivets. After the riveting was accomplished the calking was done by pneumatic tools.

Another part of the job which presented some difficulty was the fact that the new plates and seams needed to be made watertight at points marked *"P"* in Fig. 2. For doing this a system of electric brazing was used in the following manner: At each point which was to be made watertight a piece of iron 1 foot long, properly shaped, was forced into the space between the plates. This liner was forced in until the end of the piece was flush with the butt of the plating. The current for the electric brazing was furnished by the ship's dynamo, working at 60 volts. A small block of melted iron was attached on the sunken plate in front of the point which was to be made watertight, in such a manner as to wholly cover the opening

into which the liner had been forced. Twelve points required electric brazing, and the whole work was accomplished in 30 hours.

After the above work was accomplished the entire double bottom plating under the main engines had been rebuilt, all the plating being now 1 inch thick. The three hydraulic jacks were again put in place under each engine with their rams at the highest point of the stroke, and by lowering all the wooden blocks a distance of 2 inches each time, and allowing the water to discharge slowly through the pump cocks inserted between the pumps and the jacks, both engines were replaced on the new double bottom in less than two hours. After that all that remained to be done was to fit up the piping. The whole repair job was carried out almost entirely by the ship's crew, except for the blacksmith's work and the operation of the oxy-acetylene and the electric brazing apparatus. For the whole job the ship was detained in the harbor only forty-five days.

Motor Vessels for the German Navy

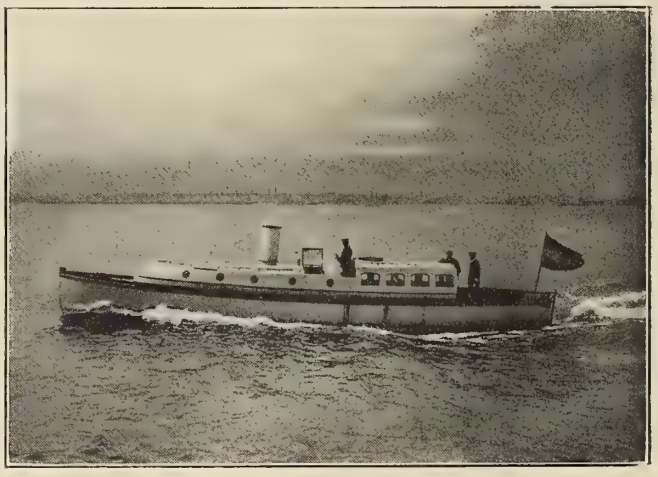
BY J. RENDELL WILSON

Apart from several large combined motor and steam warships projected for the Imperial German navy, in which the Kaiser is taking great interest, there are quite a number of small Diesel driven vessels attached to the fleet and dockyards. Of the latter the latest is a boat that has just been built at the Royal Dockyard at Kiel-Gaarden for the use of the commander of the North Sea Station at Helgoland. The engines, however, were constructed by Messrs. Benz & Co., of Mannheim. *Kommandantur Helgoland*, as she is named, is practically a raised deck type motor yacht, rather than a war vessel, and is 64 feet long by 13 feet beam and 4½ feet draft. Over the raised deck just forward of midships there is a fully closed-in pilot house, aft of which are the funnel and the

KOMMANDANTUR HELGOLAND

engine room skylights, and abaft again is a pole mast. The funnel is for carrying away the exhausts and for ventilation. Then comes another cabin and a cock pit.

The propelling engine has considerable interest, as it is a Diesel of the Benz-Hesselman two stroke type—that is to say, there are four working and two maneuvering cylinders, operated off the same crank shaft. The two forward cylinders contain double acting air pumps, which when the engine is running are used to supply air for scavenging the working cylinders. Control of this air is through ports in the walls of the working cylinders. For starting and reversing these two pumps become compressed air engines, control being by piston valves. By adopting this system it is only necessary to have one valve in the head of each working cylinder, namely, the fuel valve. Not only does this render the construction of the cylinder head much stronger, but the strains and stresses due to cold compressed air suddenly entering the hot working cylinders when maneuvering is thus almost entirely eliminated, as the only compressed air entering the main cylinders is the fuel injection blast. The importance of strong cylinder head construction with Diesel engines cannot be overrated, and some of the slight troubles experienced with motor



VEDETTE BOAT KAISER

ships in service have been due to cracked cylinder heads. One large marine Diesel engine completed about a year ago has no fewer than six valves, including two for scavenging, consequently the head can be little more than a valve cage. As yet this engine has not been installed. Indications tend to show that if the two stroke engine becomes generally adopted, it will be of the port scavenging class.

On trials the engine of *Kommandantur Helgoland* developed 175 indicated horsepower at 300 revolutions per minute, giving the vessel a speed of 10½ knots. Supposing a mechanical efficiency of 62 percent, the shaft power would be 109 brake horsepower, but probably the actual brake horsepower was nearer 120. The fuel consumption was 0.232 kilogrammes of gas oil of 39,600 B. t. u. per brake horsepower. Maneuvering trials were also carried out and the engine was started ten times in five minutes without emptying the air storage bottle. For reversing from full speed ahead to full astern the average time was seven seconds, the quickest being five seconds, which is quicker than most steam engines. The lowest engine revolutions were 160 per minute. At the trials the German Admiralty expressed their satisfaction regarding the running and maneuvering of the machinery.

Another Benz Diesel-engined boat just built for the German navy is the *Kaiser*, a vedette cruiser 49 feet long by 6 feet 6 inches beam by 3 feet 3 inches draft. She is entirely decked in except for a cock pit aft. Her engine develops 100 horsepower, and instead of being of similar construction to the one just described, they are of the four-stroke type. Messrs. Benz have engines for two sister craft under construction, also two 120 horsepower motors for two boats for the Friedrichsort torpedo range. Altogether they have built, or are building, 27 marine Diesel engines for commercial and naval craft, including three 530 horsepower tug boats.

ILLUMINATING ENGINEERING SOCIETY.—The annual convention of the Illuminating Engineering Society will be held at the Hotel Schenley, Pittsburg, Sept. 22 to 26.

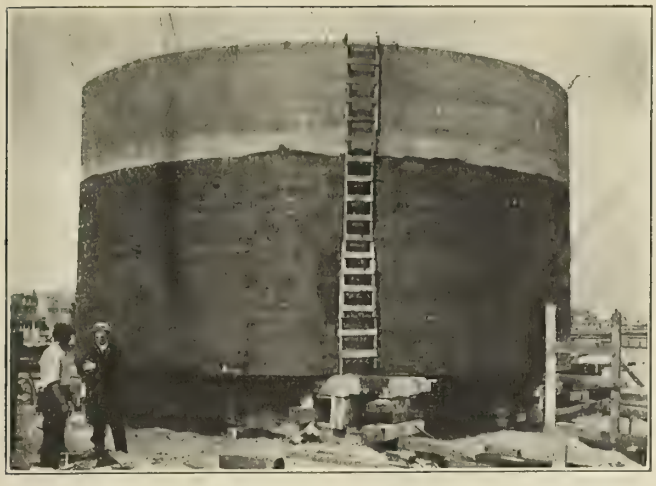


FIG. 1.—CONCRETE CAISSON TO FORM LIGHTHOUSE BASE

FIG. 2.—PREPARATIONS FOR LAUNCHING CONCRETE CAISSON

A Unique Craft

An interesting launching will soon take place at Lewes, Del. It is the launching of the caisson shown in the accompanying photographs which has been constructed alongside of Queen Anne's Pier, about 100 feet from the shore.

This caisson is to form the base of a new lighthouse that is being erected by the Interstate Construction Company near the present lighthouse in Delaware Bay, about ten miles above Lewes.

The caisson is of concrete and weighs 220 tons. It is 35 feet in diameter and 18 feet 6 inches high and will draw about 8 feet of water when afloat. It has outer and inner walls of concrete 6 inches thick and several feet apart with radial webs connecting the two walls. The bottom is also strengthened by deep radial webs.

Some dredging will have to be done in order to launch this unique craft.

When launched it will be towed to its destination and sunk by the admission of water. It will then be firmly secured in place and filled with rock.

Twin-Screw Tug for Brazilian Navy

BY F. C. COLEMAN

Messrs. Vickers, Ltd., of Barrow-in-Furness, have delivered to the Brazilian navy the twin-screw tug *Guarany*, illustrated in the photographs and drawings. The *Guarany* is being used for towing battleships and other large vessels in and around Rio harbor, and she has a length between perpendiculars of 128 feet, a breadth, molded, of 25 feet, and a depth, molded, of 14 feet.

The propelling machinery consists of two sets of triple-expansion engines, each set having three cylinders working on three cranks, the collective independent horsepower being 1,200, with a working pressure of 180 pounds per square inch. A piston valve is fitted to each high-pressure cylinder, a trick valve to each intermediate pressure, and a double-ported slide valve to each low-pressure cylinder, separate loose faces being

FIG. 1.—OCEAN-GOING TUG GUARANY FOR BRAZIL

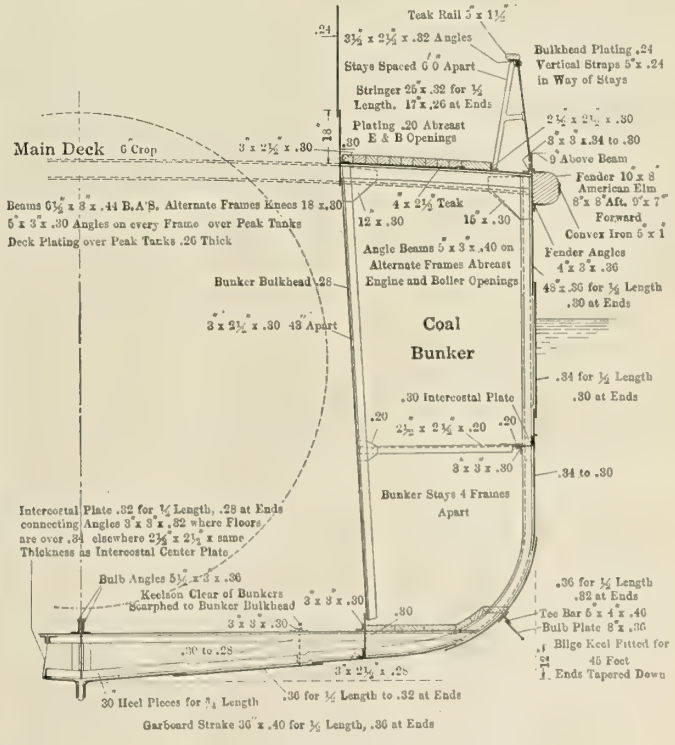

Teak Rail 5" x 1½"
3½" x 2½" x .32 Angles
Bulkhead Plating .24
Vertical Straps 5" x .24
in Way of Stays
Stays Spaced 6' 0" Apart
Stringer 25" x .32 for ½
Length, 17" x .26 at Ends
Plating .20 Abreast
E & B Openings
2½" x 2½" x .30
3" x 3" x .34 to .30
9" Above Beam
Fender 10" x 8"
American Elm
8" x 8" Aft, 9" x 7"
Forward
Convex Iron 5" x 1"
Fender Angles
4" x 3" x .36
Main Deck 6" Crop
3" x 2½" x .30
Beams 6½" x 3" x .44 B.A.'S, Alternate Frames Knees 18 x .30
5" x 3" x .30 Angles on every Frame over Peak Tanks
Deck Plating over Peak Tanks .26 Thick
4" x 2½" Teak
12" x .30
16" x .30
Angle Beams 5" x 3" x .40 on
Alternate Frames Abreast
Engine and Boiler Openings
Bunker Bulkhead .28
3" x 2½" x .30 48" Apart
Coal
Bunker
48" x .36 for ½ Length
.30 at Ends
.34 for ½ Length
.30 at Ends
.30 Intercostal Plate
2½" x 2½" x .20
3" x 3" x .30
.34 to .30
Bunker Stays 4 Frames
Apart
Intercostal Plate .32 for ½ Length, .28 at Ends
connecting Angles 3" x 3" x .32 where Floors
are over .34 elsewhere 2½" x 2½" x same
Thickness as Intercostal Center Plate
Bulb Angles 5½" x 3" x .36
Keelson Clear of Bunkers
Scarphed to Bunker Bulkhead
3" x 3" x .30
.36 for ½ Length
.32 at Ends
Tee Bar 6" x 4" x .46
Bulb Plate 8" x .36
Bilge Keel Fitted for
45 Feet
Ends Tapered Down
.30 to .28
3" x 2½" x .28
30 Heel Pieces for ¾ Length
.36 for ½ Length to .32 at Ends
Garboard Strake 36" x .40 for ½ Length, .36 at Ends

FIG. 2.—MIDSHIP SECTION OF TUG GUARANY

provided in each case. All the valves are actuated by double eccentrics and Stephenson link motion with large bearing surfaces. The bedplate is of cast iron and carries six bearings, the bushes of which are lined with white metal. The shafting is of mild steel in excess of Lloyd's requirements, the crankshaft being built in one length. Steam all-round reversing engines are fitted, the reversing shafts being of wrought steel with cast steel levers shrunk on.

A complete installation of independent steam-driven auxiliary machinery is fitted, and comprises two vertical air pumps, two centrifugal pumps for supplying circulating water to the condensers, one main and one auxiliary feed pump, one general service pump, one sanitary pump and one steam-driven electrical generating set for lighting the ship. Ballast tanks are fitted at the forward and after ends of the vessel for trimming purposes, and the bunkers are of a capacity to hold about 100 tons of coal.

The officers and crew are berthed on the lower deck forward and aft, with lavatory and bath accommodation on the lower deck.

A powerful salvage pump is fitted on the lower deck forward. A complete set of diving gear has also been provided. Provision has been made aft for lifting heavy anchors by means of a portable steel derrick. A steam steering engine is fitted on the bridge, and the gear is also arranged to work by hand power. A powerful steam windlass and winch are provided on the upper deck forward.

The vessel is lighted throughout with a complete system of electric lights, and is also provided with a powerful searchlight, which is placed on the top of the chart house. Two steel lifeboats are carried on the bridge deck. An installation of wireless telegraphy has also been fitted on the vessel. A very complete system of natural and artificial ventilation has been fitted. Two large towing hooks with springs are fitted, together with the usual towing rails.

The vessel underwent a series of trials off Barrow-in-Furness, and a speed of 11 knots was easily mantained under adverse weather conditions.

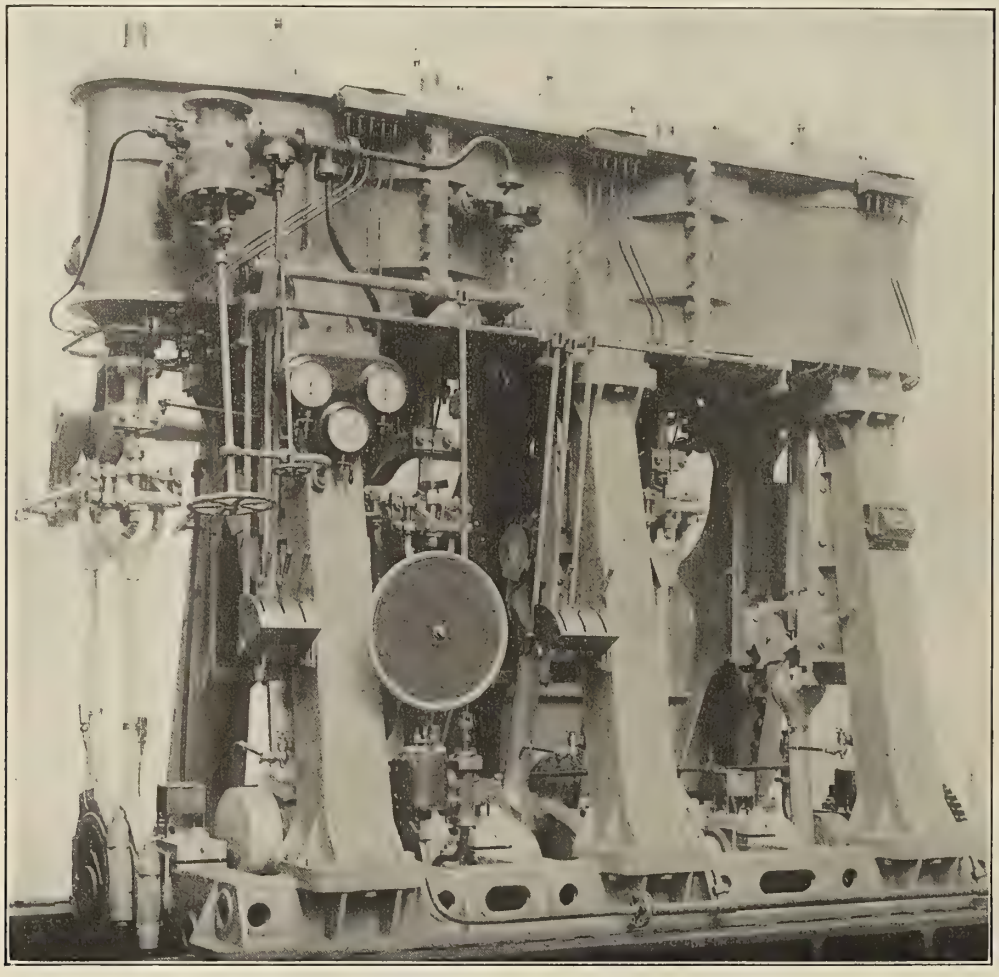


FIG. 3.—ONE OF THE MAIN ENGINES OF BRAZILIAN TUG GUARANY

Trial Trip of a Steel Screw Steamer

On July 2 the new steel screw steamer *Scythian*, built by Messrs. Ropner & Sons, Ltd., of Stockton-on-Tees, made her official trial trip in the Tees Bay. The steamer has been built to the highest class at Lloyd's, and is of the two-deck type, the second deck being 9 feet below the upper deck. Her dimensions are: Length, 403 feet 6 inches; breadth, 50 feet 6 inches; depth, molded, 30 feet 6 inches, with a deadweight carrying capacity of 7,925 tons on her summer freeboard. She has a full poop, in which are berthed the crew, bridge 115 feet long and top gallant forecastle. Double derricks are fitted to work out each hatchway, and all her appliances for loading and discharging cargoes are very complete, including a special derrick to lift 15-ton weights from either the fore-main or after-main holds; she is also fitted with an electric light installation throughout the ship. The engines and boilers have been supplied and fitted by Messrs. Blair & Company, Ltd., of Stockton-on-Tees, and are of the triple expansion type, having cylinders 26 inches by 43 inches by 71 inches by 48 inches stroke, steam being supplied by three single-ended boilers, each 15 feet by 11 feet 3 inches long with a working pressure of 180 pounds. After some very satisfactory trial runs, during which the vessel attained a speed of over 12 knots, she proceeded to the Tyne to load.

How to Increase Marine Terminal Capacity

BY H. McL. HARDING*

As has often been stated, both steamship and railway terminals are not only congested, but this congestion is becoming more and more acute, especially on account of the great increase of miscellaneous or package freight. The composition of many cargoes has radically changed within the past ten years, both in character and in the number of consignees or marks.

On account of the tendency being to convert raw material, at the place of origin, into manufactured products, the bulk shipments do not increase in the same ratio as have those of general merchandise. The tendency is even to change a portion of the grain or corn shipments into packages of breakfast or other foods.

The importance of the package freight to the transportation companies is considerable, owing to its value permitting freight rates of the higher classifications, and its augmented tonnage is desirable if it can be moved properly.

This merchandise, being of every kind, size and description, requires careful handling at terminals to avoid breakage and the resultant damage claims. In addition there is equired an extensive floor space to avoid the expense of high tiering, and this means longer distances for the usual hand-trucking, less rapidity in transference and more expense. There is generally an average of feight increase of 100 percent every ten years.

To the above causes are due the continuing expenditures of millions at terminals. If there can be obtained a greater capacity of quay walls, piers and sheds, due to superior equipment for loading, discharging and storing freight, the enormous investments can be greatly reduced.

Terminals sometimes can be enlarged by purchasing more land, but as these terminals are usually located near the business centers of large cities, the excessive cost is often prohibitive, and commerce at many ports has been starved due to the lack of money for necessary enlargements.

This paper is the result of a recent trip of the writer abroad to study terminal conditions, with special reference to sea and river ports, as well as to ascertain the trend of the developments of the different kinds of freight handling machinery, so as to be able to afford facilities for more cars or steamships to be accomodated at existing terminals.

There was also a desire to be able to recommend such mechanical appliances as would not only merely attain, but which would fully satisfy the conclusion of the Twelfth International Navigation Congress in Philadelphia, as to the mechanical equipment, to which reference is made.

From an acquaintance with terminal operating conditions, and from a study as to the application of standard machinery, it became evident that the greatest capacity at existing terminals could be attained at the least expense by higher tiering by machinery, by utilizing space remote from the front of the quay wall or the pier side, and by a greater rapidity of economical discharging and loading, this latter by removing the drafts of the winch or gantry crane as soon as possible. Any

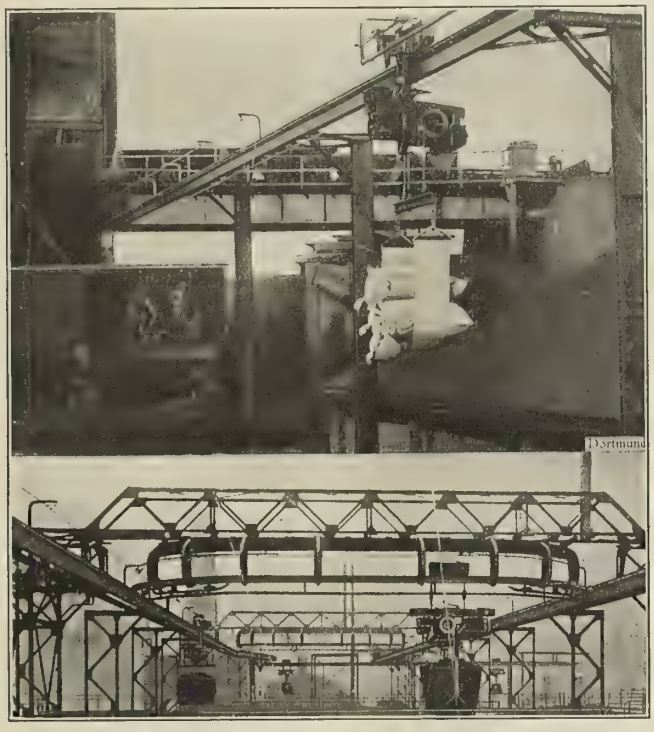


FIG. 1.—MECHANICAL CONVEYOR AT DORTMUND, GERMANY, TRANSFERRING GOODS ELECTRICALLY TO FREIGHT CARS. LOADS ALREADY ASSORTED FOR CONSIGNMENT WILL BE LOWERED UPON A SMALL TRUCK FOR MOVEMENT INSIDE THE CAR

FIG. 2.—MOVABLE TRACKS. ONE ELECTRIC CARRIER AND LOAD IS TRAVERSING THE CROSS TRACK OVER THE YARD AREA, ANOTHER IS UPON THE FIXED SIDE TRACK AND A THIRD UPON A FIXED END TRACK

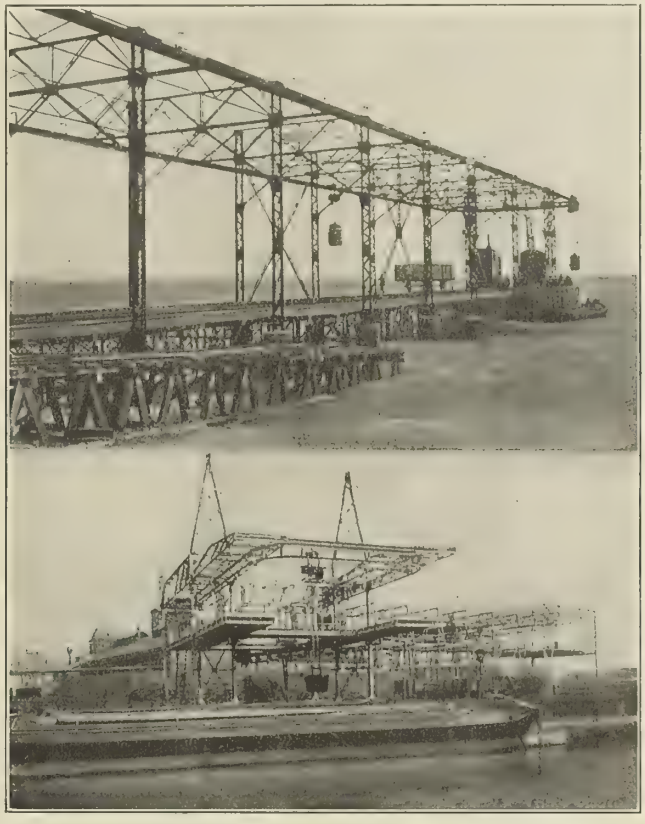


FIG. 3.—OVERHEAD RUNWAY ERECTED ON CONCRETE SUPPORTS. OVERHEAD CARRIERS EQUIPPED WITH ELECTRICAL HOISTS WHEREBY LOADS CAN BE TAKEN FROM THE VESSEL FOR DISTRIBUTION TO SHEDS AT THE REAR OF OF THE PIER

FIG. 4.—HINGED TRACK FOR MOVING CARGOES OF BULK MATERIAL RAPIDLY FROM THE VESSEL TO THE SHEDS IN REAR. MOVABLE TRACKS SERVE CUBICAL SPACE

* Consulting Engineer on Freight Terminals, 17 Battery place, New York.

such adaptations of machinery should be applicable to the designs of new terminals.

The following conditions were regarded as essential: That the original cost should be low; that the mechanism must be simple, easily and economically operated and with small maintenance cost; that it can be installed without interfering with present operations; that it must involve no new untried machinery.

As pertaining to higher tiering, including distributing and assorting, in the United States and foreign countries, the average height of tiering cargoes is about five feet—that is, that is, for a given investment, there would be approximately four times the yard, shed or pier capacity. The significance of this is appreciated when the enormous cost of port and other terminals is considered.

Unless such machinery should be able to move the freight to or from any part of the terminal with continuous rapidity, without delays and without rehandling (that is, without congestion), it will not be successful. It is useless to try to achieve mechanical success at terminals and ignore these three principles.

In respect to utilizing areas remote from the quay walls,

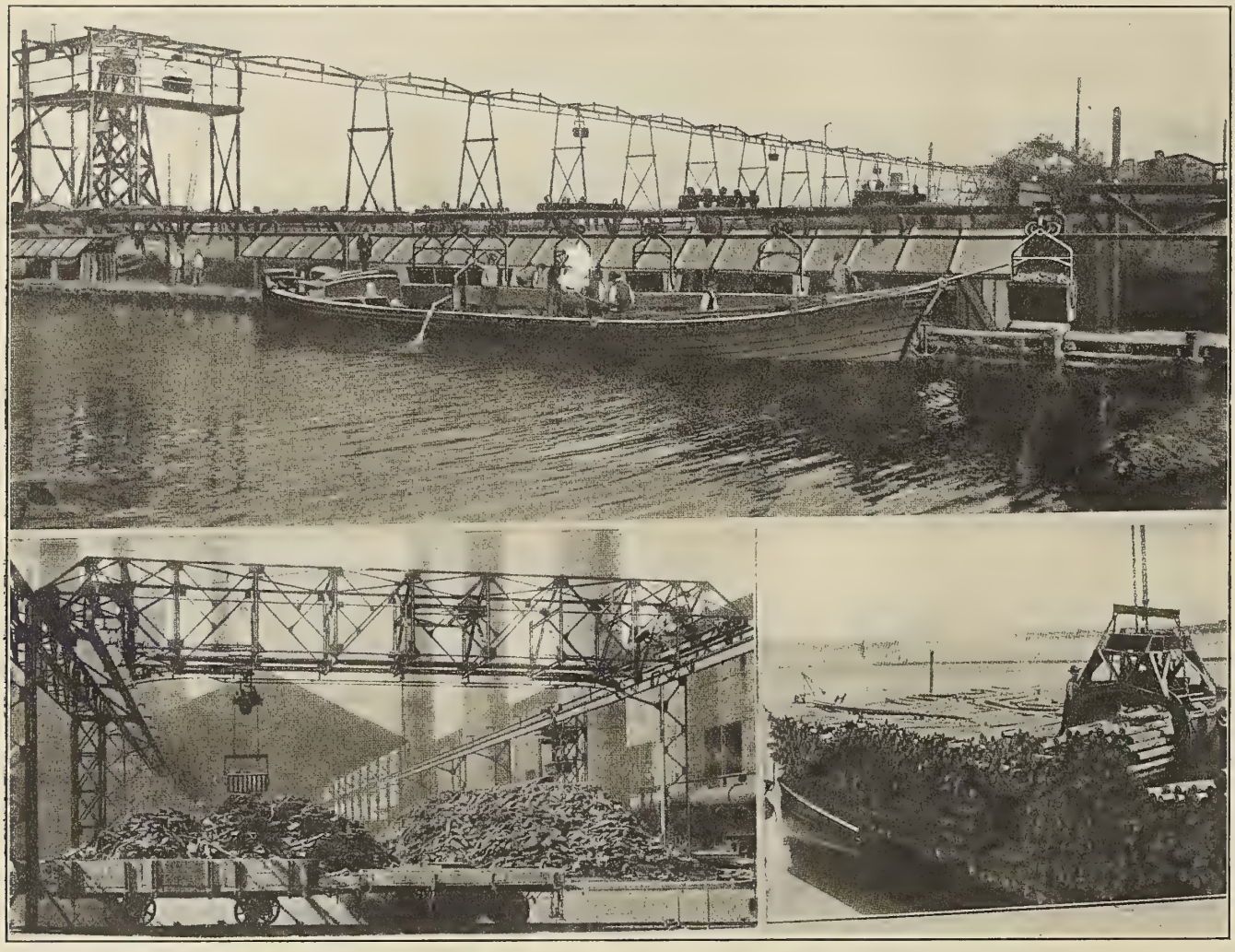


FIG. 5.—OVERHEAD RUNWAYS AT DIFFERENT LEVELS, SIX ELECTRIC CARRIERS OVER VESSEL AT THE SAME TIME

FIG. 6.—MOVABLE TRACKS FOR SERVING ANY PORTION OF THE YARD

FIG. 7.—ENLARGED VIEW OF GRAB FOR UNLOADING BARGE

as high as one man can readily lift. The reason for this is that where the tiering is higher, say to fifteen feet, the cost of handling is often doubled. It is found cheaper to move the freight many hundred feet horizontally, than five feet more vertically—that is, ten feet—and piling to fifteen or twenty feet is always avoided whenever possible.

If, therefore, any machinery should be found which would distribute, assort and tier over the whole terminal area and do the work rapidly without rehandling by manual labor, thus eliminating congestion, it is evident that the capacity of a pier, or of a transshipment shed or freight house, would be multiplied several times. The importance of the machinery being able to distribute and assort must not be overlooked.

If, instead of tiering five feet, the goods can be raised to twenty feet without additional expense for lifting, then the capacity of the pier or shed would be increased four times; if such spaces can be served by conveying machinery without rehandling, then less shed or pier space would be required to be reserved for temporary holding or storage, and the areas reserved would provide for placement for the more rapidly unloaded cargo. Similarly, outgoing cargo could be taken from such spaces in less time than it now takes from the usual pier or quay wall shed.

The greater rapidity of discharging is effected by removing the drafts more quickly from the winch or gantry fall-rope. Where gantries are already installed, or where it is desired to use the ship or dock winch, then such machinery would supplement their work.

The mechanism, however, should be able, if preferred, to take the merchandise from the hold or from the deck of a steamship or river barge, or from the side of the pier to any part of the terminal, and also perform the reverse movements.

From the above it will be seen that it seemed best to lay emphasis upon the conditions which must be fulfilled by any machinery, and then to find that machinery which would satisfy these conditions.

There are many other conditions which it was most desirable to avoid; as, for example, the occupying by any machinery of floor space which should be reserved for the holding or storage of freight.

It costs only about 3 cents (1½d.) a ton to hoist from the ship's hold to the side of the pier or the quay wall; but the subsequent movements of distribution and assorting to the various parts of the pier shed add nearly 30 cents (1s. 3d.). It, therefore, might be more advantageous to apply the transferring machinery to the terminal distribution, and to utilize the ship's winch or the gantry crane as at present.

The chief difference between the results achieved by the ship's winch and the gantry crane is rapidity. At the foreign terminal ports, especially those of Germany, England, Holland and Belgium, the speed of discharging and loading, so as to secure more voyages for the ships and to utilize to the utmost the working capacity of the quay walls, are the chief reasons for the extensive installations of gantry cranes.

While there may be not so much difference in the speed of hoisting, of the winch and crane, yet on account of the gantry being able to serve a greater area, thus avoiding the congestion caused by the winches at the place of deposition, greater final speed is obtained.

FIG. 8.—TRANSFERRING GOODS FROM HOLD OF VESSEL TO WAREHOUSE. A SWITCH ENABLES LOADS TO BE TRANSFERRED TO OTHER WAREHOUSES. THE BOOM EXTENDING OVER THE VESSEL IS HINGED FOR RAISING TO CLEAR SHIP'S RIGGING

FIG. 9.—MECHANICAL TRANSFER OF MISCELLANEOUS FREIGHT AT RIVER LANDING

From a large number of views, the following have been selected to illustrate a type of transferring machinery installed at several localities, chiefly in Germany. That they are of recent construction indicates the trend of development. Although below each picture is a short description in explanation, yet a reference to the special features of each will serve to illustrate their fulfilling the principles contained in this article.

In Fig. 8 (the upper view) the load is taken from the vessel

to the warehouses. The lower picture is an excellent illustration of conveying to remote areas. In Fig. 2 (lower picture) is the moving track serving area at a long distance from the shore. In Fig. 3 the loads are taken from the winch or the gantry to the land area. In Fig. 5 is shown rapidity of movement by many electric cranes. Fig. 6 shows how space is served without rehandling. A short study of these different views will indicate that they will fulfil the conditions described in this paper.

Conclusions

First. The performance of the gantry crane, or of the deck or ship's winch can be supplemented by far-conveying distributing and assorting machinery.

Second. This mechanism can be of the overhead runway type, with movable tracks and with electric traveling conveyors, as now manufactured by German, English, French, American and other manufacturers.

Third. That by high tiering by such machinery there can be a greatly increased capacity of piers, transshipment sheds and storage areas.

Fourth. That there can be secured a greater rapidity in removing from the place of deposition the drafts of cranes and winches, thus avoiding congestion.

The National Character of the Navy

At the annual banquet of the American Society of Naval Engineers, Rear Admiral Robert S. Griffin, chief of the Bureau of Steam Engineering, pointed out in a striking manner the national character of naval work, showing how widely that work is scattered and how eventually the money expended for naval work goes back to all the people and not into the pockets of a small privileged class of men. He said in part:

"To many the building of battleships means the employment of a certain number of men in one of the Atlantic coast shipyards. It never seems to occur to these people that when the building of a battleship commences an impetus is given to trade in many of the States of the Union, and that the work actually done at the shipyard consists largely in assembling material whose manufacture, either as a whole or a part, is scattered over a large part of the country. Our iron ore comes from the great iron ranges of the Northwest, from Alabama and Tennessee, and some from Cuba. The materials necessary for converting the ore into steel material ready for use comes from such other States as Illinois, Pennsylvania, Ohio and Maryland, and nearly all of the steel material is produced in these States. The copper comes from Michigan and Montana, and is made into merchantable material in New York, New Jersey, Massachusetts, Michigan, Ohio and Connecticut. The wood comes from North Carolina, Georgia, California and Oregon. The manufactured articles which are supplied to the builders ready for installation—and they comprise a large portion of what goes to make up what we call a battleship—come from the great manufacturing States of the East, and from Ohio, Indiana, Illinois, Michigan and Wisconsin, and these States draw on others for their raw material, or for their shop equipment and other material necessary for carrying on their business.

"When the ship is completed a change takes place, and the States which had little or no hand in the building of the ship come to the front in furnishing the supplies necessary for the maintenance of the crew and for the operation of the ship. We draw upon the great agricultural States of Illinois, Missouri, Iowa, Kansas, the Dakotas, Minnesota, Nebraska and Texas for corn and wheat products and for meats for provisioning our ships. The cotton belt is in evidence by a considerable outlay for the manufactured articles represented by the product of that part of the country. The bulk of our coal comes from Maryland, Virginia and West Virginia, and some from Pennsylvania. Texas is also the principal source of our supply of oil for fuel, California having, as yet, furnished comparatively little, and Louisiana and Oklahoma still less. Virginia also has something of a monopoly in the supply of manufactured tobacco, though it draws on other tobacco-producing States for the raw material.

"It should be remembered that this 'trade' from the navy is no small item, for while we build only two battleships a year (and sometimes only one), we maintain twenty-one battleships in full commission and a number of others and of inferior vessels in reserve. The food supply alone for the fleet costs annually nearly as much as a battleship without armor and armament, while the fuel costs one-half as much. The other supplies are less in value, but I think I have shown enough to make it clear that the bulk of the money spent on the navy eventually finds its way back to a large majority of the people of the whole country."

Admiral Griffin also made some interesting statements regarding the growth of engineering in the navy during the past twenty-five years. Twenty-five years ago the total horsepower of the navy was then less than 90,000 in ships built. To-day it is nearly 2,250,000, or twenty-five times as much as it was twenty-five years ago, and our most highly-powered ship has engines of 32,000 horsepower against the *Chicago's* 5,000. This enormous increase in the engine power of our ships has, naturally, brought with it a large increase in cost, but the cost has not been in proportion to the power; for while the power has increased twenty-fivefold, the cost of maintenance of machinery has increased only tenfold, notwithstanding a very material increase in the cost of labor.

A glance at what has been done in the past four years will show how economically the engineering side of the navy has been operated. During these four years the horsepower of our ships has increased more than 35 percent—in figures about 562,000, which is equivalent to the power of twenty battleships of the *Delaware* class—and it is a significant fact that the appropriation for the up-keep and operation of that machinery is actually less by $400,000 (£82,000) than it was four years ago.

This means more than appears on the surface. Four years ago a number of our capital ships were out of commission, and the readiness of their machinery for active service was something that would have to be put in the doubtful column in considering the availability of a ship for a sudden call. To-day the machinery of every ship is ready, and those in reserve are capable, on the shortest notice, of proceeding to sea and taking their place with the fleet, without any apprehension on the part of the Department as to their ability to stay there and meet every demand.

Another thing to be taken into consideration in the comparison is that the cruising speed of the fleet is higher, and that the ships are driven harder than ever before, which, of course, means greater wear and tear, and relatively greater cost of up-keep, and it should be a matter of pride that all this is being accomplished for far less than we spent on a smaller navy four years ago.

Argentine Battleship Rivadavia.—The Argentine battleship *Rivadavia* will leave the works of the Fore River Shipbuilding Company, Quincy, Mass., on Aug. 3, and will proceed to New York, where arrangements have been made to dock the vessel in No. 4 drydock at the Brooklyn navy yard, where the necessary under-water overhaul and painting will be completed. The vessel will be taken to the Rockland (Maine) measured mile course about Aug. 11 for her standardization and endurance trials, which, at the request of the Argentine Naval Commission and the contractors, will be conducted by the Board of Inspection and Survey of the United States navy.

New Steamers for Central Vermont Railway

The steamers *Narragansett* and *Manhattan*, for the Long Island Sound service of the Central Vermont Transportation Company between New York City and New England ports, are now rapidly approaching completion at the yards of the builders, the Harlan & Hollingsworth Corporation, Wilmington, Del.

These steamers are of the twin-screw type, and are intended, primarily, for passenger service, although space and handling appliances are also provided for carrying express freight.

They are designed and powered for a speed of 20 miles an hour; for although the schedule to be maintained calls for a speed of only 17 miles an hour, extra power has been provided; so that time can be made up in case of delay by fog or head tides.

The steamers were designed and the construction superintended by Naval Architects Frank E. Kirby and J. W. Millard & Bro., and they are also built to the requirements and under the special survey of the English Lloyds Classification Society, all of which means that they are of the highest possible standard.

The general dimensions of these new vessels are:

	Feet
Length over all	332
Breadth, extreme	66
Depth, molded to main deck	22

The hulls are of steel and, to insure safety in the event of damage, are divided into separate compartments by eight main watertight bulkheads: They are also provided with a cellular double bottom, which is closely divided into separate watertight compartments.

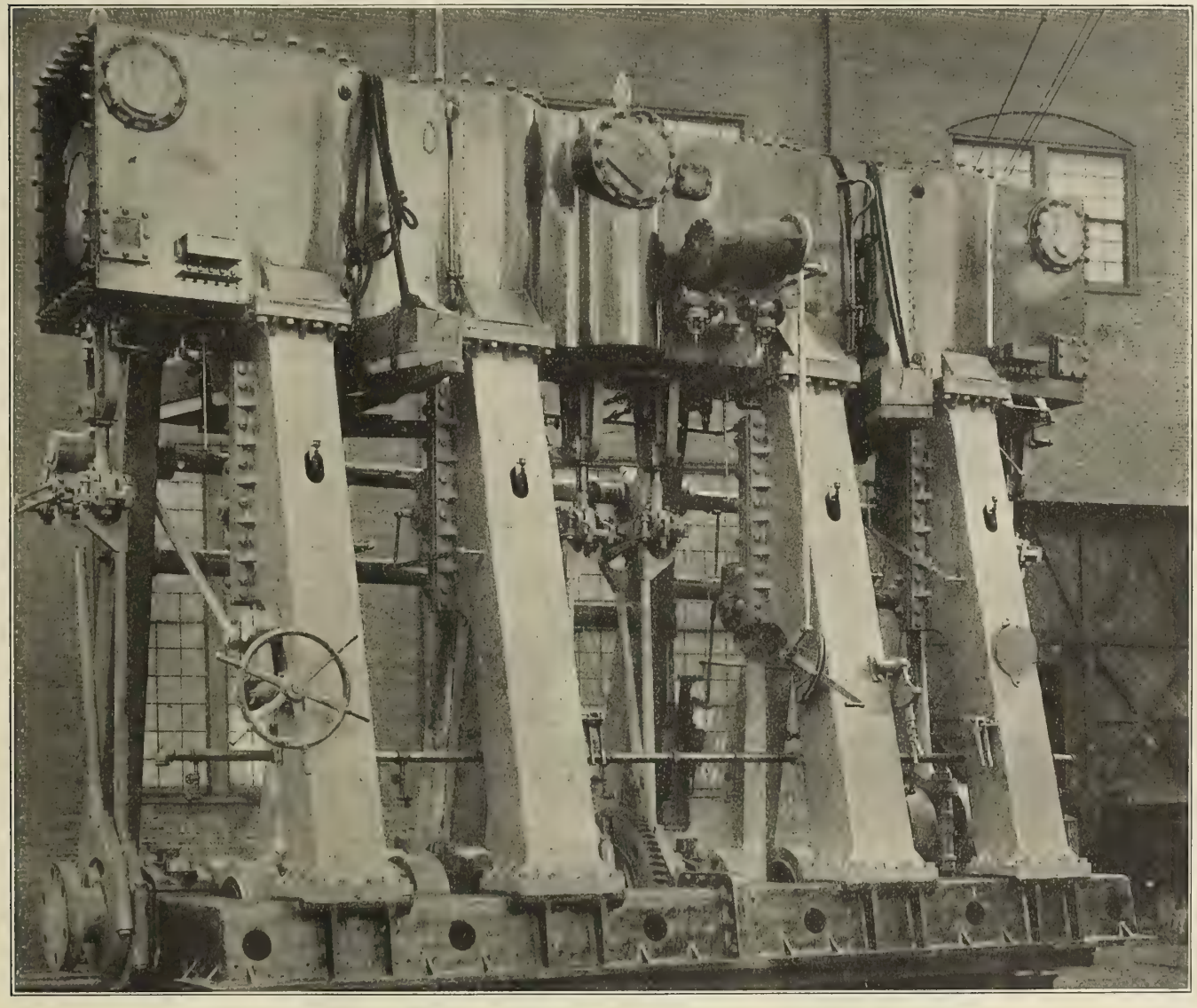


FIG 1.—TRIPLE EXPANSION ENGINE FOR ONE OF THE NEW CENTRAL VERMONT RAILWAY STEAMERS

The propelling machinery consists of twin-screw engines, triple expansion, with four cylinders and cranks balanced on the Yarrow, Schlick, Tweedy system to ensure smooth running and freedom from vibration. The indicated horsepower is about 5,000.

There are six boilers of the cylindrical return-tube type fitted with Howden's forced draft, allowed a steam pressure of 185 pounds per square inch, and the up-takes are fitted with cinder catchers of improved design.

Each engine is complete, with its own separate condenser,

FIG. 2.—VIEW OF HARLAN AND HOLLINGSWORTH SHIPYARD SHOWING STEAMERS NARRAGANSETT AND MANHATTAN UNDER CONSTRUCTION.

feed, air and circulating pumps, etc.; in fact, the whole power plant is in duplicate, thus practically eliminating any possibility of breakdown.

Most complete provision has been made for the safety and comfort of the passengers.

The dining saloon is on the main deck aft of and connecting with the entrance lobby. The dining room is Colonial in design, with mahogany wainscot and ivory white above.

Two private dining rooms are provided, finished in ivory white with silk panels on the walls. The decking in the dining saloon is of linoleum tiling and the furniture of mahogany.

The entrance lobby is finished in mahogany in the Doric style, and the floor is covered with rubber tiling. At the after end of the lobby is a wide mahogany staircase leading up to the main saloon, and the staircase well is surmounted with a handsome dome, glazed with cathedral glass. At the after end of the main saloon is the music room, finished in white mahogany. Over 100 staterooms connect with the main saloon, including four parlor staterooms with brass beds and with private bath rooms. Immediately above the main saloon is the gallery deck, accommodating 100 staterooms, including parlor staterooms with private bath rooms, same as on saloon deck.

FIG. 3.—STEAMER NARRAGANSETT NEARING COMPLETION

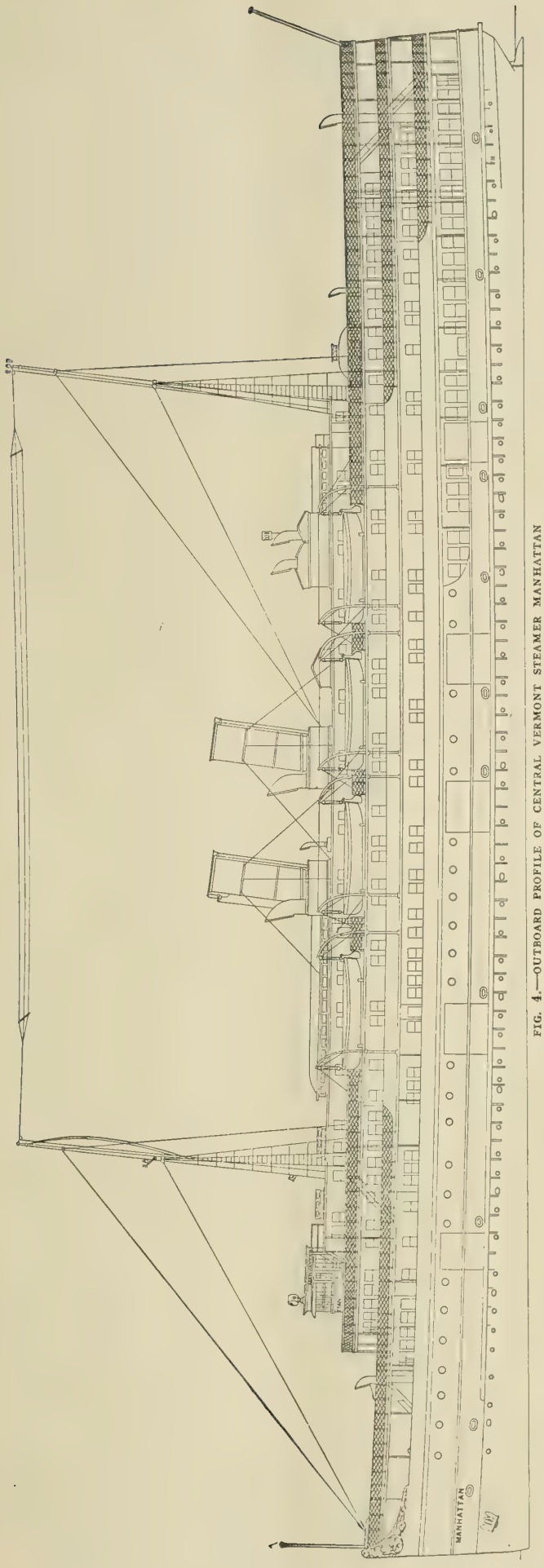


FIG. 4.—OUTBOARD PROFILE OF CENTRAL VERMONT STEAMER MANHATTAN

At the after end on the gallery deck is provided a grill and café, finished in quartered oak. At the forward end of the gallery deck is an observation room with a semi-circular glass front, commanding a fine view forward. The hurricane, or boat deck, besides accommodating forty staterooms, provides a roomy promenade.

A feature is that a large number of staterooms have each a private toilet room with water closet and wash basin, but no bath tub. By dividing the space necessary for one bath room into two toilet rooms a much larger number of staterooms are provided with toilet rooms, and it is believed that this plan will be popular. On each deck there is a large general lavatory for men and one for women, and each stateroom will have its own porcelain wash basin served with running water.

Special mention should be made of the accommodation provided for second class passengers. The line expects to carry a large number of high-class immigrants bound for Canada and the Far West, and quarters have been provided for them far superior to what is usual. The forward parts of the saloon deck, the main deck and the lower deck will be reserved for second class passengers; on the saloon deck will be staterooms with berths, and on the lower deck large, airy cabins with berths providing accommodation for about 150 people. On the main deck will be a lunch room and lavatories for the second class passengers.

The vessel will be brilliantly lighted by electricity, the whole installation being most modern and complete, consisting of three large turbine generating sets and including a large searchlight. There will be a complete system of electric bells, also telephones, and a wireless telegraph will be installed for maintaining communication with the shore.

Particuar attention has been paid to protection from fire. All woodwork through the cargo space is insulated with sheet iron and asbestos, the bulkheads in the crew's and other quarters are of steel instead of wood, the whole main deck is of steel with no wood on it, and all casings extending up through the ship are of steel.

Two fire-resisting bulkheads are provided, extending through all the passenger decks to the dome, dividing the vessel into three fire compartments, and an independent sprinkler system is provided for the cargo spaces and the second class quarters on the main deck. Supplementary to this there is an automatic fire alarm system fitted all through the ship, also fire hydrants in numerous positions on every deck.

A steam heating plant on the vacuum system of capacity to comfortably heat the vessel in the coldest weather has been installed.

Annual Meeting of the Society of Naval Architects and Marine Engineers

The twenty-first general meeting of the Society of Naval Architects and Marine Engineers will be held at 29 West Thirty-ninth street, New York, on Thursday and Friday, Dec. 11 and 12. The annual banquet will be held at the Waldorf-Astoria Friday evening, Dec. 12. Hitherto the usual time of holding the annual meeting of this society has been in November, but this year a later date was chosen in order to accommodate the members and their friends from the Great Lakes. Owing to conditions existing in that region in November many members of the society have been unable to attend the meetings, but by postponing the meeting to a later date it is hoped that a substantial increase in attendance will result and likewise a considerable increase in the membership of the society. An unusually interesting programme of technical papers is being prepared, covering the latest developments in naval architecture and marine engineering, and it is expected that the meeting will prove of particular value and interest.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER *

CHAPTER XI (Continued)
Engine Fittings

"Chief," interrupted O'Rourke, "you can't go much further aft without telling us about propellers, can you?"

"For once, O'Rourke, you are right, as that is certainly the next step.

"The subject of propellers is one of the most interesting connected with marine engineering. Volumes have been written about them, and nearly every engineer of any standing in the business has, at one time or another in his career, attempted to invent a new kind that would be far superior to any other propeller ever made. The Patent Office contains about as many propeller designs as there are ships on the seas. About one of these designs in ten thousand is of any practical use, so let me warn you young men never to let your fancies run to the idea that you can invent a propeller.

"The whole science of propeller designing is based on a process of evolution. Do you know what 'evolution' means, O'Rourke?"

"Sure!" said he of Irish extraction. "That means that man is descended from a monkey."

"You have the idea all right, and the modern propeller has about the same relation to the original propeller as a man bears to his original, in accordance to the theory of a certain philosopher named Darwin.

"When propellers were first invented, the idea was that they should be as large as it was possible to have them. A story is told of an old-time coasting steamer fitted with an engine of five or six hundred horsepower driving a four-bladed propeller about 15 feet in diameter. She was ambling up the coast one day at a 6-knot clip when the propeller struck a log; whereafter, as the story goes, she immediately increased her speed to 7 knots. On examination it was found that one of the blades had been broken off, a fact which immediately started the theory that a three-bladed propeller was the proper thing to use. As a matter of fact, the increased speed was undoubtedly due to the reduction in area of an excessively large propeller.

"The best designed propellers of to-day are those built in accordance with data derived from propellers which have been in use. Step by step they have been improved upon until it seems that we have to-day reached a point where but little more improvement can be made. The crude propellers used on the first screw steamers and all propellers used since that time have been useful in developing the modern propeller, as it has been from actual experience, and after very expensive experience, too, that perfection in propeller design has been gradually approached.

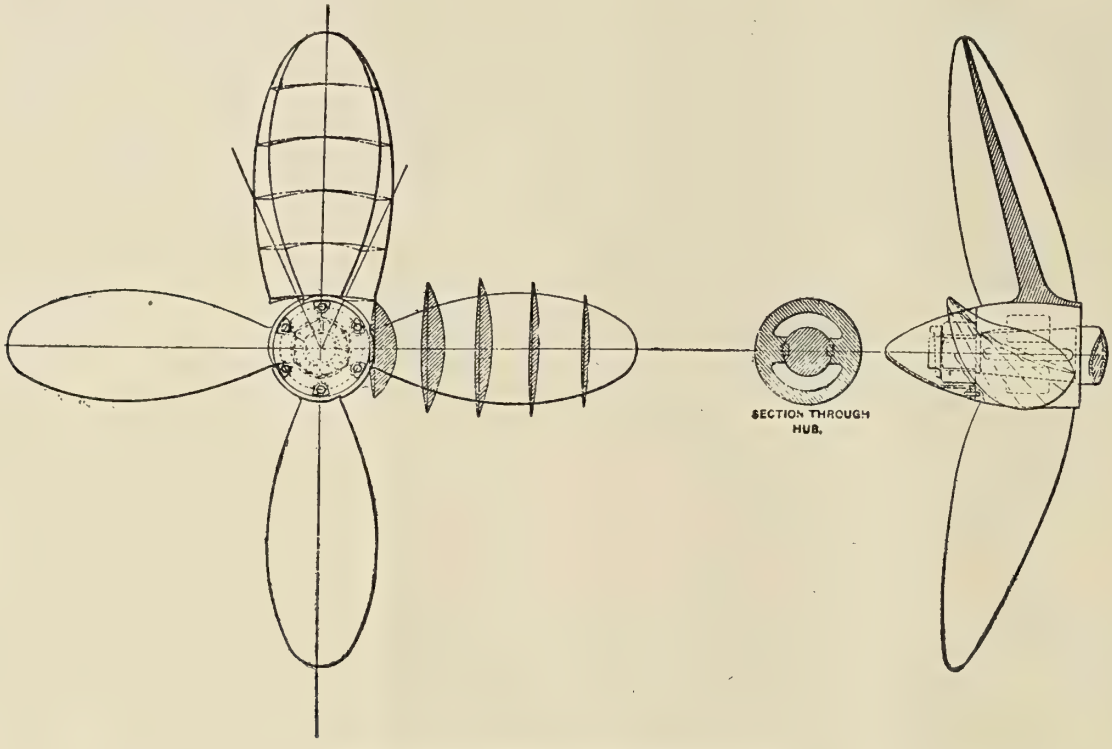


FIG. 21.—SCREW PROPELLER, BLADES CAST WITH HUB

"The results of all these years of experimenting have evolved a standard wheel with uniform pitch and blades elliptical in shape set at right angles to the shaft axis, or slightly raked aft from the perpendicular, according to the individual fancy. The great majority of propellers are now four-bladed, a small portion of them three-bladed, and occasionally we see a two-bladed propeller on an auxiliary vessel.

"Propellers, small in diameter, are almost invariably made solid; that is, the hub and blades are cast in one piece, such as shown in Fig. 21.

"Larger propellers are of the 'built-up' type; that is, the blades and hub are cast separately and the blades are flanged and bolted to the hub. The advantages of this type are that in case any of the blades are broken they can be replaced without throwing away the entire wheel, and, further, that

*Engineer-in-Chief, U. S. Revenue Cutter Service.

by slotting the holes in the blade flanges the pitch can be altered if deemed necessary."

"What material is best for propellers?" inquired Nelson.

"That depends on how much money you have," replied the chief. "In fact it is something like buying underclothes. A poor man buys cotton and it serves the purpose; a man of moderate means buys woolen—that serves the purpose better; a rich man would buy silk, and that is better than any of the others.

"With propellers, cast iron serves the purpose and is cheap; cast steel is stronger and costs a little more; bronze is stronger, smoother and lasts longer, but costs much more than either of the other materials."

"I think Schmidt must wear a cast iron undershirt, judging from the rust he has on it," suggested O'Rourke.

"If shipowners but knew it, polished manganese bronze or other high-class materials would be much cheaper in the end than cast iron or cast steel. A screw driven into wood encounters considerable friction, and you will be surprised to learn that the screw-propeller driven through the water also encounters a great deal of friction. Experiments have shown that from 10 to 20 percent of the total power of the engine is consumed in overcoming the friction of the screw. Hence it pays to have the blades made as smooth as possible to reduce this frictional loss. Recent experiments of rubbing graphite on the blade surfaces demonstrate that an appreciable amount of friction is reduced by means of that lubricant."

"What do they mean by the pitch of a propeller?" asked Pierce.

"McAndrew picked up a bolt that was lying on a bench, and said: "I hold this nut rigid in my hand and turn the bolt head one complete revolution; you will see that the end of the bolt has advanced about 1/16 inch out of the nut—that is what is called the 'pitch' of the thread on the bolt. So with propellers, the pitch is the distance the ship should be driven ahead by one revolution of the screw if it was driven through a solid. But water is not solid by any means, and hence the ship does not advance the distance it should; the difference between what it does advance and what it would advance in a solid is called the 'slip.' This term is always expressed in percentage; for example, if the pitch of the screw is 20 feet, and the ship is driven ahead only 17 feet at one revolution of the engine, the slip is 3 feet, and there would be said to be a 15 percent slip, as 3 is 15 percent of 20."

"How do you tell whether a propeller is right or left-handed?" asked Schmidt.

"The best way to tell that is to imagine yourself in the bottom of the dry dock looking forward at the propeller. When the screw is driving the ship ahead and it turns in a direction corresponding to the motion of the hands of a watch it is called right-handed. If in the opposite direction then it is left-handed.

"The driving face of a blade is not, as you might imagine, the forward side, but the after side, as it is that side which acts on the water; therefore the back of a blade is its forward side."

"That sounds Irish," said Schmidt, glancing at O'Rourke.

"The area of a propeller, sometimes called the helicoidal area, is the sum of the actual areas of all of its blades.

"Later on I will try to show you how to calculate the pitch of a propeller by measing the wheel in position."

CHAPTER XII

Condensers, Air and Circulating Pumps

The repairs to the *Tuscarora* were rapidly nearing completion; the new boilers were in place, much of the connecting piping had been gotten out and the end of the job was in sight. The students of the "Floating School" had not lost interest in their voluntary work, although their regular duties were now much harder than at the commencement of the repairs. McAndrew had looked for his pupils to slacken in their interest in his lectures, but no one had missed a single evening which he had devoted to their instruction. In consequence he had determined to carry the course through for them, and on this particular evening in early March he opened his remarks by saying:

"Well, boys, this work I know is rather dry to you, but later on we will get into something more interesting to you. I propose to cover all the principal parts of marine machinery by these lectures, and then to give you some practical questions on the subject and to show you how various problems are worked out.

"Up to date I have tried to instruct you in a general way as to how steam is generated and how it is utilized to produce power. We now come to the part where, having used the steam, we must get rid of it. This is a step second only in importance to generating the steam. We have seen that by applying heat to water in the boiler steam is formed; the condenser serves directly the opposite purpose, for therein the heat is taken out of the steam and it returns to its original state—water. Some people look at the condensers as if there were something mystifying about its action, but the process of condensation is simplicity itself. The very atmosphere we breathe acts as a condenser, for you no doubt have noticed how readily steam escaping from an exhaust pipe is turned into water simply by contact with the air, and especially is this noticeable on a cold day.

"You might think that in the steam as it leaves the engine there is but little heat left, and as a matter of fact the temperature is only about 110 degrees F.; but you must remember the first principles and realize that the temperature as shown by the thermometer is only the sensible heat. Do not forget that when the water was transformed into steam it took about 934 heat units, known as the latent heat, to bring about this change of state. To turn the steam into water again this latent heat must be taken out in order to accomplish the change, and, approximately speaking, there are 1,000 heat units per pound of steam to be carried off by the cooling water. Herein lies one of the great wastes of any steam plant, and unless the exhaust steam can be utilized for heating the feed water, or for heating buildings in the case of shore plants, there is no way yet devised to prevent it."

"Chief," interrupted Pierce, "I don't understand how this exhaust steam can have so low a temperature as 110 degrees F., when you told us that steam did not form until the thermometer stood at 212 degrees F."

"I see," replied the instructor, "that you did not grasp the idea of water boiling at different temperatures according to the pressure it is under. It is true that under atmospheric pressure it does not form steam until 212 degrees, but as the pressure is reduced the boiling point is lowered accordingly. Steam leaving the low-pressure cylinder of an engine is at an absolute pressure of only a pound or two corresponding to a vacuum of 26 or 27 inches, and if you were to boil water in such a vacuum you would find that steam forms at a temperature of approximately 110 degrees. Hence it is that the exhaust steam has such a low temperature.

"Fortunately the best medium for condensing steam is cool water, so on shipboard the supply of cooling water is, of course, close at hand. The condenser, as the apparatus for bringing about the transformation from steam to water is termed, is made in two principal types for marine purposes. The jet condenser consists of a large cylindrical casting into which the exhaust steam passes, and where it comes in contact with jets of water which transform or condense the steam to water. As the condensing water is used in such large quantities it must be pumped overboard, together with the water of condensation. For vessels sailing on fresh water such a device is cheap, economical and highly efficient, but for

vessels plying in salt water where the condensed exhaust steam must be used over and over again for boiler feed, jet condensation is absolutely useless. Hence we have what is known as the surface condenser, wherein the steam does not come in direct contact with the circulating or cooling water.

"Surface condensers are made either cylindrical or rectangular in section, according to the space which they are to occupy. When they are built in the engine framing, as most frequently happens in merchant vessels, they usually have a cylindrical top with flat sides and bottom, strongly ribbed to prevent collapse from the external pressure of the atmosphere. At each end of the condenser there is what is known as a water chest for the entrance and exit of the circulating water. The greater portion of the interior of the condenser is filled with small brass tubes, usually 5/8 inch outside diameter, running lengthwise, and fitting into what are known as tube

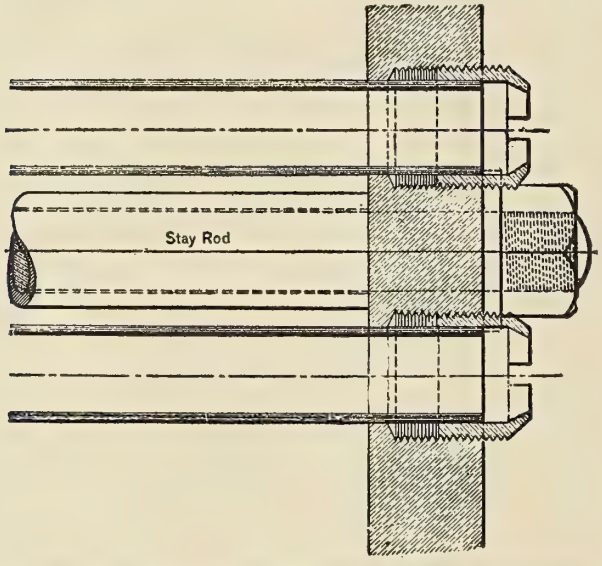


FIG. 22.—FERRULES AND TUBE PACKING IN SURFACE CONDENSER

sheets, one at each end of the condenser. These tubes are spaced very closely together, and through them flows the cool sea water. The exhaust steam as it enters the condenser thus comes in direct contact with the outer surface of these small tubes and is quite readily transformed into water. In order to prevent the steam from striking the tubes in one spot directly opposite the exhaust pipe, it is customary to fit a perforated baffle plate opposite the opening for the exhaust, which baffle plate scatters or deflects the steam along the entire length of the tubes. It is, of course, highly essential that the condenser be kept as tight as possible, for if there are any leaks the salt circulating water will be forced into the body of the condenser, where it will mix in with the condensed steam and find its way into the boilers. Hence great care must be exercised in packing the ends of the innumerable small tubes. Fig. 22 will show you how these tube ends are made tight.

"Holes are tapped in the tube sheets into which are screwed small glands known as ferrules, and the packing space is usually filled with corset lacing."

"Gee!" exclaimed O'Rourke, "they ought to carry lots of girls on ships to furnish all that corset lacing."

"You will notice," continued McAndrew, "that the ends of these glands or ferrules are beaded over slightly. That serves the purpose of preventing the tubes from crawling out of place on account of the contraction and expansion due to the varying temperatures to which these long, slender metal tubes are subjected. It also allows them to expand without starting to leak, as would otherwise be the case.

"If condenser shells are cylindrical in shape it is usual to make them from rolled steel plate, but if they are of rectangular section they are almost invariably made of cast iron. The tube sheets are always made of composition. The tubes themselves are made either of brass or Muntz metal, usually coated outside and inside with tin, although many designers do not think that this tinning process is now necessary. At the water ends, particularly, where iron and brass are in such close proximity, it is very important to see that a sufficient amount of zinc plates is suspended in the water to prevent galvanic action. Some careful engineers also have zinc plates fitted in baskets in the fresh-water side of the condenser for the same purpose, although these are not so essential there as in the water chests.

"This evening as I was coming into the engine room I noticed you boys looking around the main condenser, so I supposed you were trying to study its connections."

"Yes," replied O'Rourke, "Schmidt was trying to find how the air got into the air pump when there is only steam goes into the condenser."

"I suppose," replied McAndrew, "that the air gets in the air pump just about the same way that water gets in the milk we buy at the corner grocery—it's put in. The term 'air pump' is really a misnomer; to be sure, there is a small amount of air gets into the condenser with the steam, but the main function of an air pump is to pump the condenser water out of the condenser, and incidentally any air and vapor that may be there.

"Air pumps on board ships are, as a rule, vertical, and of two general types, connected and independent. By 'connected' we mean that they are worked through the medium of beams from one of the crossheads of the main engine, usually the low pressure. The principal advantages of this arrangement are the certainty of action so long as the engine is running and the economy of operation, as the power is, of course, furnished by the main engine, which is generally of the most economical multiple-expansion type. Its disadvantage is that there is no vacuum while the main engine is not running. This, however, is not great, as the vacuum is produced almost at the first stroke of the main engine.

"An 'independent' air pump is one that is driven by its own steam cylinders; and as a rule this type is uneconomical, as the economy of operation is only equivalent to that of a slow-running simple engine. There is an advantage, of course, in always having a vacuum in the condenser whether the main engine is running or not. Unless an independent air pump is of very good design and kept in good order, there is always a likelihood of its stopping at the most inopportune times. In this they closely resemble a mule who will work along all right until, perhaps, when crossing a railroad track, he will get balky just as a train is coming along."

"Do you start a balky pump the same way that you would start the mule?" inquired Pierce.

"Very much the same," replied McAndrew. "I once had an Irish oiler with me who would occasionally get mad when the air pump stopped, and would strike it on the valve chest with a top-maul. Very frequently the pump would start off immediately on being given that treatment, probably because the jar would start the controlling valve which had stuck. However, I do not recommend such strenuous treatment of balky pumps, and you had better not let me catch any of you striking pump valves that way on board this ship.

"The air pump itself is usually of the same design, whether operated independently or attached to the main engine. Fig. 23 will show you the type usually adopted for marine work.

"Air pumps are always attached to the very lowest part of the condenser, so that the water of condensation will flow to the pump by gravity. In the sketch you will note that the pump is not unlike any ordinary style of pump for pumping liquids. The valves form the main distinguishing feature. There are, as you will see, three sets of these valves; the ones at the bottom being termed 'foot valves,' those in the piston are

known as 'bucket valves,' and the set of valves at the top are 'discharge valves.'

"The method of operation is that as the bucket or piston starts on its upward stroke a vacuum is produced in the pump barrel, which, when it overcomes the vacuum in the condenser, causes the water, air and vapor to rush through the foot valves into the body of the pump. On the down stroke the contents of the pump are in turn discharged through the bucket valves, and on the following up-stroke are forced through the discharge valves at the top, whence they go to the hot well or feed tank. You will notice that the top plate on the pump which contains the discharge valves is not bolted to the pump in this sketch, but is held down by a large spiral spring. This is what is known as a floating top, and it is thus arranged so as to allow the ready escape of a large volume or gulp of water which is liable to pass through the pump at any time. Quite often pumps which have not been provided with bucket on a large mass of water which could not escape quickly a floating top have had the top broken by the impact of the enough through the small valves. Most large air pumps are made of cast iron, fitted with a thin composition liner. The bucket should be of composition, and the top and bottom valve plates should also be made of the same material.

"The air pump valves nowadays are usually made of several light bronze disks of decreasing diameters, the largest diameter being at the bottom. These are held down by light bronze wire spiral springs. Some engineers, however, still prefer vulcanized rubber valves.

"You will notice that the bucket shown in this sketch has a number of grooves turned in its rim; these are supposed to trap small quantities of water and thus prevent leakage from one side to the other. Ordinarily buckets of this kind are fitted with bull rings and packed with square hemp packing, as that is much more reliable than the so-called water packing.

"Pumps above 18 or 20 inches in diameter are usually fitted with a manhole in the side of the barrel, so as to provide ready access to the bucket and foot valves without removing the top and the bucket as well whenever it is necessary to examine the lower sets of valves.

"What pump on board of a ship do you think has the easiest job?" inquired McAndrew, trying to test the knowledge of his pupils.

"I know," quickly said O'Rourke, "it's the pump in the firemen's washroom when Schmidt is taking a bath—he's afraid of water."

"I haven't heard of any pump handles being broken when you were taking a bath, either," retorted Schmidt.

"Well, you will have to decide the bathing proposition yourselves," remarked McAndrew. "But what I wanted to call to your attention is the fact that the circulating pump, a very important adjunct of marine machinery, has comparatively little hard work to do. In condensing the exhaust steam a very large quantity of circulating water is used, as for every pound of steam condensed there is required under ordinary conditions the cooling effect of about 30 pounds of sea water. Thus for a 4,000-horsepower engine, using about 16 pounds of steam per horsepower each hour, there would be required about 3,800 gallons of circulating water per minute. This water has, however, only to be pumped with sufficient force to overcome the friction through the tubes and the small head due to forcing it overboard a few feet above the pump. The requisite force is so small that on fast torpedo boats there is a scoop arrangement at the in-take which, when the vessel is going at full speed, is sufficient to drive the circulating water through the condenser without the help of the pump.

"The pump almost universally used for circulating purposes is of what is known as the centrifugal type—with the accent on 'trif' and not on the 'fug,' as I have heard some of you boys pronounce it. By the way, does any of you know the meaning of 'centrifugal?'"

Not even O'Rourke ventured a reply, so McAndrew informed his hearers that "'centrifugal' means 'flying from the center,' the opposite effect, or 'flying towards the center,' being expressed by the word 'centripetal.' A pump of the centrifugal type is therefore one in which the water entering at the center is driven outward by a revolving series of blades called the 'runner,' and is discharged through an opening in the casing which is connected by a pipe to the condenser. This is an ideal type of pump for circulating the water through the condenser, inasmuch as a large quantity of water can readily be handled at a small expenditure of power. Pumps of this description are ordinarily operated by a single-cylinder engine

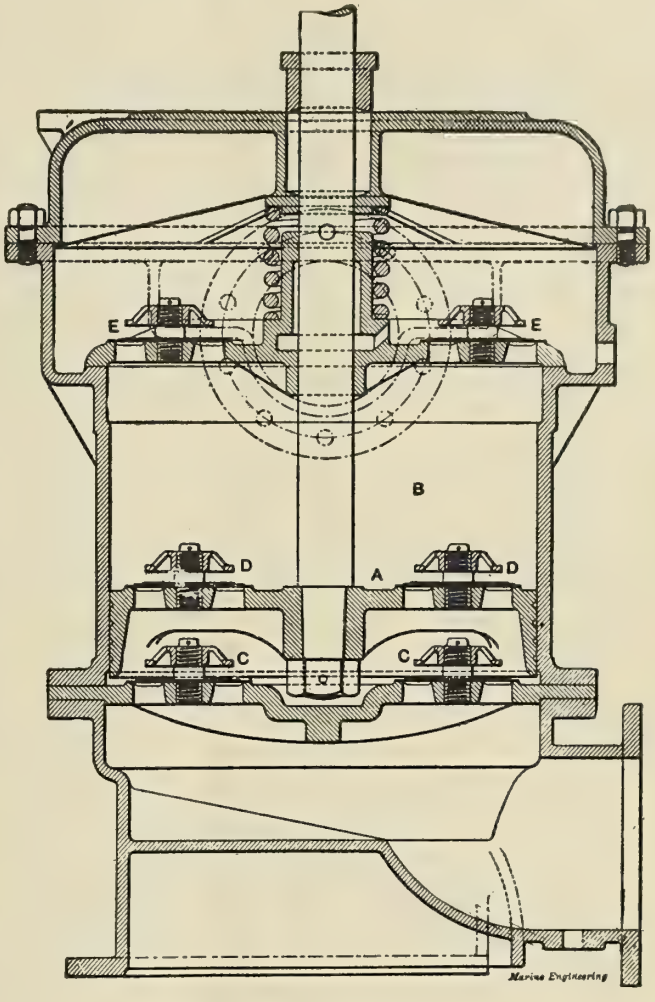


FIG. 23.—VERTICAL ATTACHED AIR PUMP

of the usual type. An extension of the crankshaft of the engine forms the shafting for the pump runner, and inside the pump casing this shafting is usually encased in composition. The runner is generally cast of composition, but with the exception of small pumps the pump casing is made of cast iron, in halves, flanged and bolted together. Pumps of this description need but little attention, as there are no valves to get out of order as is the case with the ordinary types of reciprocating pumps. Being of such an advantageous type, centrifugal feed pumps are now used on shipboard to a limited extent, little difficulty being encountered in forcing water into a boiler against a pressure of as high as 200 pounds. Feed pumps of this description are driven by small steam turbines."

"Suppose the circulating pump should break down, how would you keep running?" inquired the observing Nelson.

"There is very little possibility of such an accident occurring, but it is a wise thing to prepare for even so remote an emergency," answered McAndrew. "I have seen some ships fitted with a special discharge pipe from the fire pump

or the auxiliary feed pump to the water end of the condenser. I know of one ship in particular where the casing of the circulating pump collapsed on account of excessive corrosion on the inside. The chief engineer was a resourceful fellow, and fitted two hose connections to the small handhole plates on the water chest of the condenser; then by connecting up two lengths of fire hose to the fire main and running the auxiliary feed pump, he managed to keep sufficient vacuum in the condenser to run the engine along at half speed, and the ship got safely into port."

"Suppose your air pump busted, what would you do?" asked O'Rourke, not to be outdone in asking questions by his mates.

"Even the permanent disabling of the air pump need not put the engine out of business," replied the Chief. "If worse came to worse, you could take down the main exhaust pipe, rig up a temporary pipe out of heavy canvas, and exhaust to the atmosphere—tugboat fashion. Many steamers have a suction pipe connecting the channel-way under the air pump direct to the main feed pump. By this method the condenser can be kept clear of water, and a fair amount of vacuum maintained.

"You will find, as you live longer, that the application of good common sense and some ingenuity will help you out of many difficulties which at first seem insurmountable. These attributes are possessed by almost every marine engineer, as the very nature of his business requires a liberal use of both of them. Those are the qualities which make marine engineers the best operating engineers for any type of machinery."

(To be continued.)

Performance on Service of the Motor-Ship Suecia*

BY I. KNUDSEN

In the autumn of 1911 the Rederiaktiebolaget Nordstjernan Company, of Stockholm, ordered six motor liners from Messrs. Burmeister & Wain, the dimensions of the vessels being as follows: Length, 362 feet; breadth, 51 feet 3 inches; depth, 34 feet; carrying capacity, 6,500 tons deadweight.

The machinery consists of two main engines, each of 1,000 indicated horsepower (four-cycle Diesel engines with eight cylinders), besides two auxiliary Diesel engines, each of 200 effective horsepower, for working the compressors, auxiliary machinery (such as winches and steering gear), and for the production of the electric light; the machinery is in other respects similar to that of the *Selandia,* which was described by the author in a paper read before this Institution last year.[1]

As to passenger accommodation, there are only eight cabins for first class passengers, which is much less than is provided for in the *Selandia;* the cabins, however, are roomy and modern, and provided with bath and toilet rooms. Further, there is ample saloon accommodation, and a hospital. The *Suecia* is intended for the Sweden to La Plata service, and she will be chiefly employed for cargo purposes, being fitted with the most modern loading and discharging gear, such as double derricks and double winches.

The vessel was launched on Nov. 2, 1912, and the trial trip took place on Dec. 17, 1912. The next day she went to Limhamn, where she took in a cargo of 15,000 barrels of cement, then she sailed to Stockholm, where—as far as I know—a cargo of 4,000 tons was taken in. On Dec. 23 she left for Gothenburg, and here she took in still more cargo, and left on Dec. 31, arriving at Christiania on Jan. 1, where her cargo was completed, and on Jan. 4 a trial trip took place in the Christiania Fjord with the vessel fully laden. When the trial trip had been completed she went to London, where she arrived on Jan. 9, and went from London to Rio Janeiro, arriving at that port on Feb. 1.

I will refer to certain matters concerning the *Suecia* owing to some remarks made in the discussion of the paper which was read before the Institution of Naval Architects, to the effect that no information was given with regard to the efficiency of the propellers, etc., compared with that of ordinary steamers. The reason why no such information was given in connection with the *Selandia* was, that with this vessel no

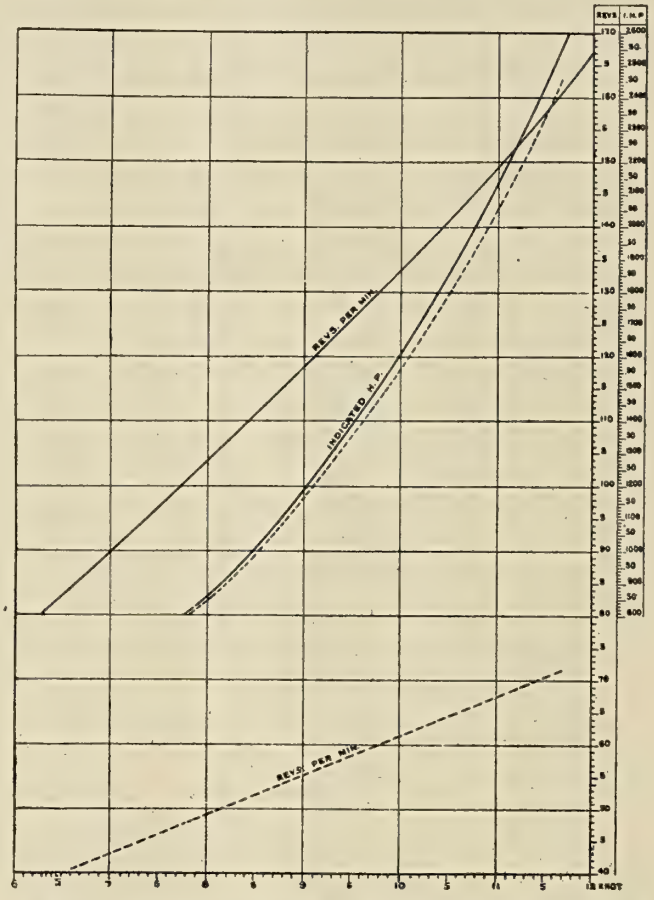


FIG. 1.—M. S. SUECIA (FULL LINES), 362′ × 51′ 3″ × 23′ (DRAFT), D. W. 6,500 TONS, COEFFICIENT 0.78; S. S. PRINCESSAN INGEBORG (DOTTED LINES), 360′ × 48′ 9″ × 22′ 4″ (DRAFT), D. W. 5,895 TONS, COEFFICIENT 0.794

trial trip took place with the ship fully laden, and consequently we possessed no comparative results. With the *Suecia,* however, we succeeded in carrying out this trial trip in Christiania Fjord, and I am glad to have this opportunity of publishing the results.

The full lines on Fig. 1 give the curves showing the indicated horsepower, the number of revolutions and the speed obtained with the *Suecia.* The dotted lines on this figure give similar particulars obtained with the *Princessan Ingeborg,* a vessel built a few years ago for the same owners, but fitted with steam engines.

As appears from the dimensions given on these diagrams, the vessels are almost alike, both in dimensions and also with regard to the fineness of lines. If the two vessels are compared it will be seen that to obtain the same speed for the same displacement the same indicated horsepower is required, whether it is to be used in the motor liner or in the steamer. According to this result, there seems to be no difference in the power required to propel a vessel, whether this is effected by means of a single, large, slow-running propeller, as in the

* Abstract of a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

[1] Trans. I. N. A., Vol. LIV, p. 68.

steamer, or by two relatively fast running small propellers, as in the motor liner. The propeller in the steamer has a diameter of 17 feet 6 inches, and in the motor liner of 10 feet.

In this respect it must be remembered that in the *Suecia* the main Diesel engines do not work the pumps nor the two first stages of the air compressors. The relation of the indicated horsepower to the brake horsepower of the engines will, therefore, be about the same as in a steam engine, and the combined efficiency of the mechanism of the engines and of the propellers is about the same as obtains with the steam engine. The weight of steam installation in the *Princessan Ingeborg* brought up to correspond with the horsepower of the motor

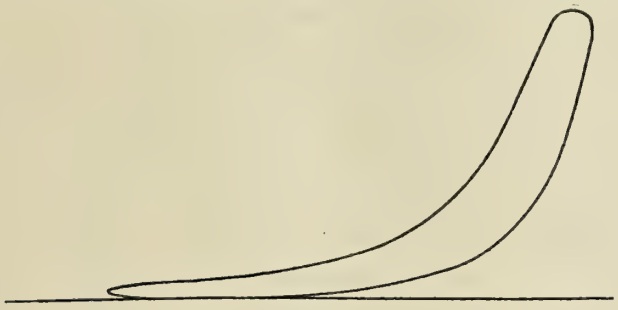


FIG. 2.

installation amounts to 570 tons, as an extra main boiler was fitted in view of the cleaning of the boilers. The total machinery in the motor ship *Suecia* weighs 470 tons. With regard to the space occupied by the engines in the *Suecia,* this is 41 feet of the length of the vessel, whereas it is 66 feet in the *Princessan Ingeborg,* although the horsepower as stated above is less in this vessel.

It should be stated that the trial trip took place under good conditions, such as fine weather and deep water. The vessel, however, has now returned from her maiden voyage, and from the speed attained on the Atlantic the comparative trial trip results seem to hold true in the practical performance of both vessels.

In the trial trip in Christiania Fjord the oil consumption per indicated horsepower-hour was measured, and a result was obtained which no doubt is the best hitherto obtained, viz., 134 grams of oil per indicated horsepower-hour, measured on the main Diesel engines, and when everything is allowed for, such as the consumption of the auxiliary engines, etc., the oil consumption per indicated horsepower of the main Diesel engines amounts to 154 grams, including the fuel oil necessary for the working of the auxiliary engines, steering engines, pumps, etc., but exclusive of the oil used for heating the vessel. The mechanical efficiency of Diesel engines of the type used, but with the whole of the compression of the air necessary for fuel injection performed by the engines themselves instead of by auxiliaries, has been shown by bench trials to be 80 percent, so that the oil consumption per brake horsepower of such a marine Diesel engine would amount to 167½ grams per brake horsepower.

The diagram, Fig. 2, which was taken during the trial trip, shows by its shape and appearance that the engine is extremely economical.

Building Fund of the Institute of Marine Engineers.—A site for the permanent home of the Institute of Marine Engineers has been secured on Tower Hill, London, and building operations will soon be commenced. The sum of £12,000 will be required for the completion of this project. Half of this amount has already been subscribed, and it is hoped that the general appeal of the Institute for donations to this project will be met with a ready response by firms and individuals interested in shipping, shipbuilding and marine engineering.

On the Trials of Three Ferry Steamers Propelled by Geared Turbines*

BY J. INGLIS

The following paper is offered in response to a suggestion from Dr. Archibald Denny during the discussion on Sir Charles Parsons' paper read at the spring meetings. Dr. Denny expressed a wish to have the results of the trials of three small vessels fitted with geared turbines, but at that time these trials were incomplete.

The vessels are named *Curzon, Elgin* and *Hardinge,* after three Viceroys of India, and are intended to connect Ceylon with the Indian mainland by a short sea passage in smooth water instead of the long and occasionally disagreeable voyage which hitherto has been the only available means of transit.

The South Indian Railway Company, owners of the vessels, applied for guidance to the late Sir William H. White, who furnished them with an outline design of the internal arrangements and a specification covering all the requirements of the service, at the same time leaving the builder a very free hand as to the form of the vessel, scantlings of material, power of propelling machinery and other details.

Sir William White's foresight was evinced by the fact that the whole contract has been completed without any alterations on the working plans or any extra charges of importance. The vessels are 250 feet long by 38 feet broad, and displace about 865 tons on 6 feet draft of water.

The principal conditions of the contract were that the vessels should carry 160 tons of deadweight on a draft of water not exceeding 6 feet, and while so loaded be capable of steaming 20 sea miles at the rate of 16½ knots, starting from rest, no allowance being made for the time occupied in getting under way. The fuel used on trials was to be as nearly as possible equivalent in heating power to the Indian coal available on service, a sample analysis being furnished which showed 63.26 percent of fixed carbon. The coal actually used contained 63.86 percent of fixed carbon, being a rather poor sample of Scotch coal, but almost exactly what was wanted. Yarrow boilers were fitted, the heating surface being 7,000 square feet and the grate 168 square feet. The boilers were arranged to be fired with oil if that should be found advantageous.

It will be observed that the actual full speed to be attained was not stated in the conditions, nor were any data available whereby it might be computed. It was considered safe to assume 17 knots, and estimates were made on that basis, as if 17 knots could be maintained for 19 miles there would be left 1 mile of distance and over five minutes of time to attain full speed. This was deemed to be sufficient.

A preliminary trial of the *Curzon* was made on Dec. 10 last to test the working of the turbines, and the weather being very calm advantage was taken of the divisions on the measured mile in the Gareloch to learn something about the acceleration of a vessel starting from rest. The results are shown on the diagrams. Fig. 1 shows, on a base of one nautical mile, the time for each fraction of a mile and the increasing speed during acceleration. Fig. 2 shows, on a base of speed in nautical miles per hour, the revolutions of propellers, the slip in knots and the slip percent during acceleration. Fig. 3 shows the revolutions, slip and shaft horsepower during a progressive trial of the *Elgin,* also the effective horsepower (which Messrs. Denny were so kind as to ascertain for us in their experimental tank) and the ratio of effective to shaft horsepower.

The dotted curves on Fig. 1 show the computed speed during acceleration, also the time required to run 1 mile starting from rest. These were constructed by Mr. Mumford, superintendent at Messrs. Denny's experimental tank, from calculations based

* Abstract of a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

on the resistance of the model. The agreement between the curves constructed from calculations made on a model and those from experiment on a full-sized ship is extremely close.

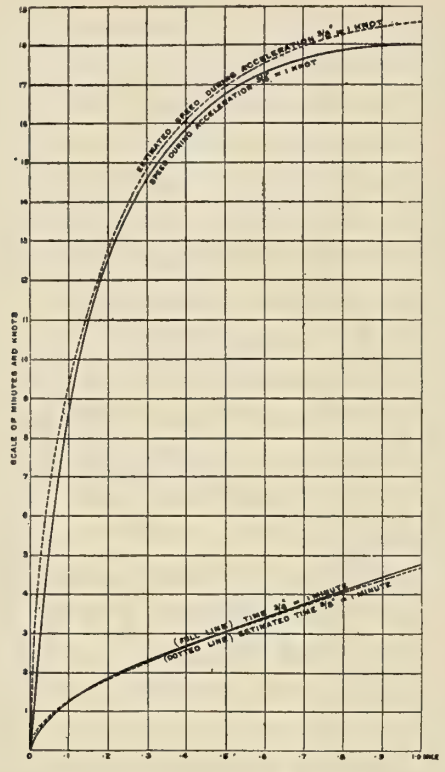


FIG. 1.—T. S. S. CURZON; DOTTED CURVES BY TANK TRIAL, FULL CURVES BY OBSERVATION

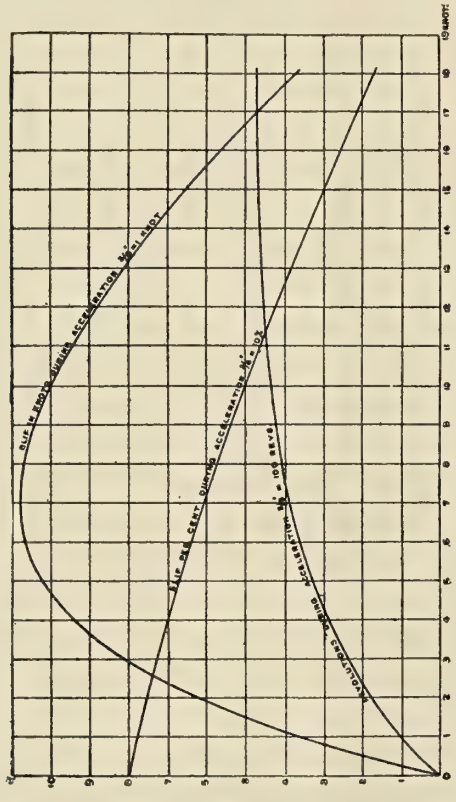


FIG. 2.—T. S. S. CURZON; CURVES ON SPEED BASE

The 20 miles distance, starting from rest, was steamed by the *Curzon* in 65 minutes, equal to a mean speed of 18.46 knots, the tide being with her for the first half and against her for the second half, the wind fresh, about three points abaft the beam. The time occupied by the *Hardinge* was 66½ minutes, equal to 18.045 knots, she having a stiff breeze against her and a weak tide in her favor, high water at Greenock being about 8 o'clock on that day. It was not considered necessary to repeat this trial with the third vessel, and instead of this a progressive trial was made on the measured mile, and a run of two hours at high speed was utilized in measuring the water consumption.

During the latter the revolutions were somewhat reduced by a strong head wind, the average being 482.8 per minute, corresponding to a speed of 17.8 knots. The mean shaft horsepower was 2,390, and the consumption of steam, for turbines only, 12.55 pounds per hour per shaft horsepower. The consumption of steam by the auxiliaries amounted to nearly 3 pounds per hour per shaft horsepower of main engines. Among the auxiliaries are reckoned the engine driving a large dynamo and the steam steering gear. The temperature of the feed was 205 degrees F. The air pressure in the stokehold did not exceed a quarter of an inch of water column.

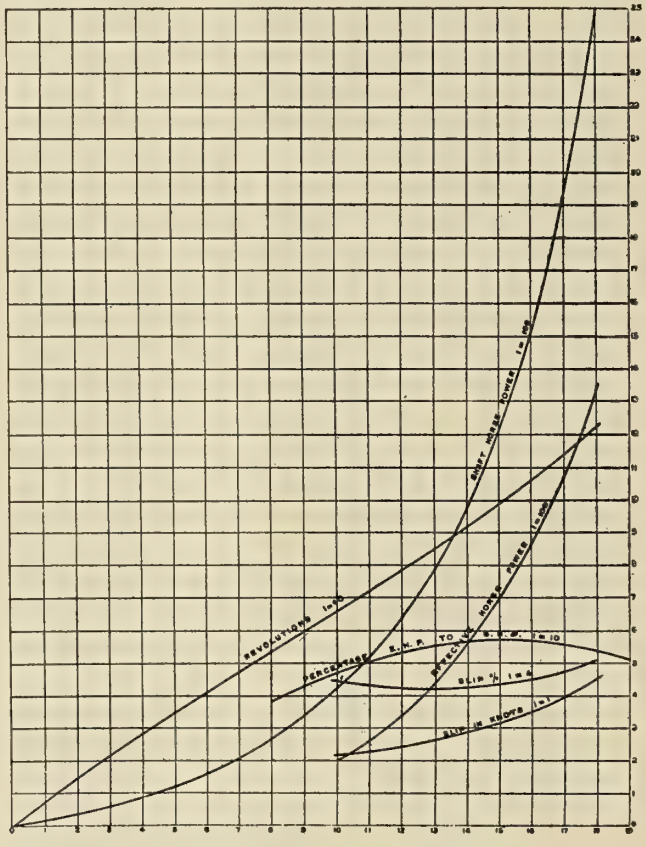


FIG. 3.—PROGRESSIVE TRIAL RESULTS

An attempt was made to record the noise of the gearing on a new phonograph obtained for the purpose; but, although the sound of the engine room telegraph gong and some vocal efforts were clearly rendered by the instrument, the sound of the gearing could not be recognized amid the scraping of the reproducer on the wax cylinder.

Professor Biles, in his interesting remarks on Sir Charles Parsons' paper, quotes a shipowning friend repelling the suggestion to permit the innovation of "cog-wheels" in a passenger steamer's propelling machinery. The use of cog-wheels cannot be regarded as a novelty even in high-class ocean-going passenger steamers. I can remember the building, in 1855, of the steamer *Oneida*, which was then deemed large, seeing that only twenty-five steamers of the same or greater register tonnage were on the Mercantile Navy List at that date. This vessel was 307 feet long by 39 feet beam. Her gross tonnage was 2,284, and her net register 1,372 tons. Her

engines were direct-acting, but the results were so unsatisfactory that before she was two years old, that is, in 1857, she was put into our hands to undergo certain alterations and receive new geared engines of about 3,000 horsepower. These engines, cog-wheels and all, appeared to work satisfactorily for seventeen years, though I fear they could not have been remarkable for economy of steam, and in 1875 she was converted into a sailing ship. Thirty years later, being then fifty years old, she disappeared from the British register, having found a new owner in Chili.

High speed of piston being somewhat of a bugbear to engineers in the fifties, geared engines were common enough in channel and coasting steamers, and even Robertson's frictional gearing, where the wheels and pinions had grooves in place of teeth, was not unknown in marine work. What was tolerated sixty years ago, with cast iron pinions and mortise wheels, might surely be adopted now with the refined methods of gear cutting which Sir Charles Parsons and others have made available.

Contract for New Mallory Liners.—An order has been placed with the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., by the Mallory Line for two new passenger steamships of 7,000 gross tons each. The new vessels will be 432 feet long overall.

Note on Some Cases of "Fatigue" in the Steel Material of Steamers*

BY S. J. P. THEARLE

Evidences of what is known as the "fatigue of metals" have from time to time been disclosed when surveying steel vessels under repair, but during the last year or two certain phenomena of the kind have been observed which possess special features, and it is thought that these may be of interest to the members of this Institution.

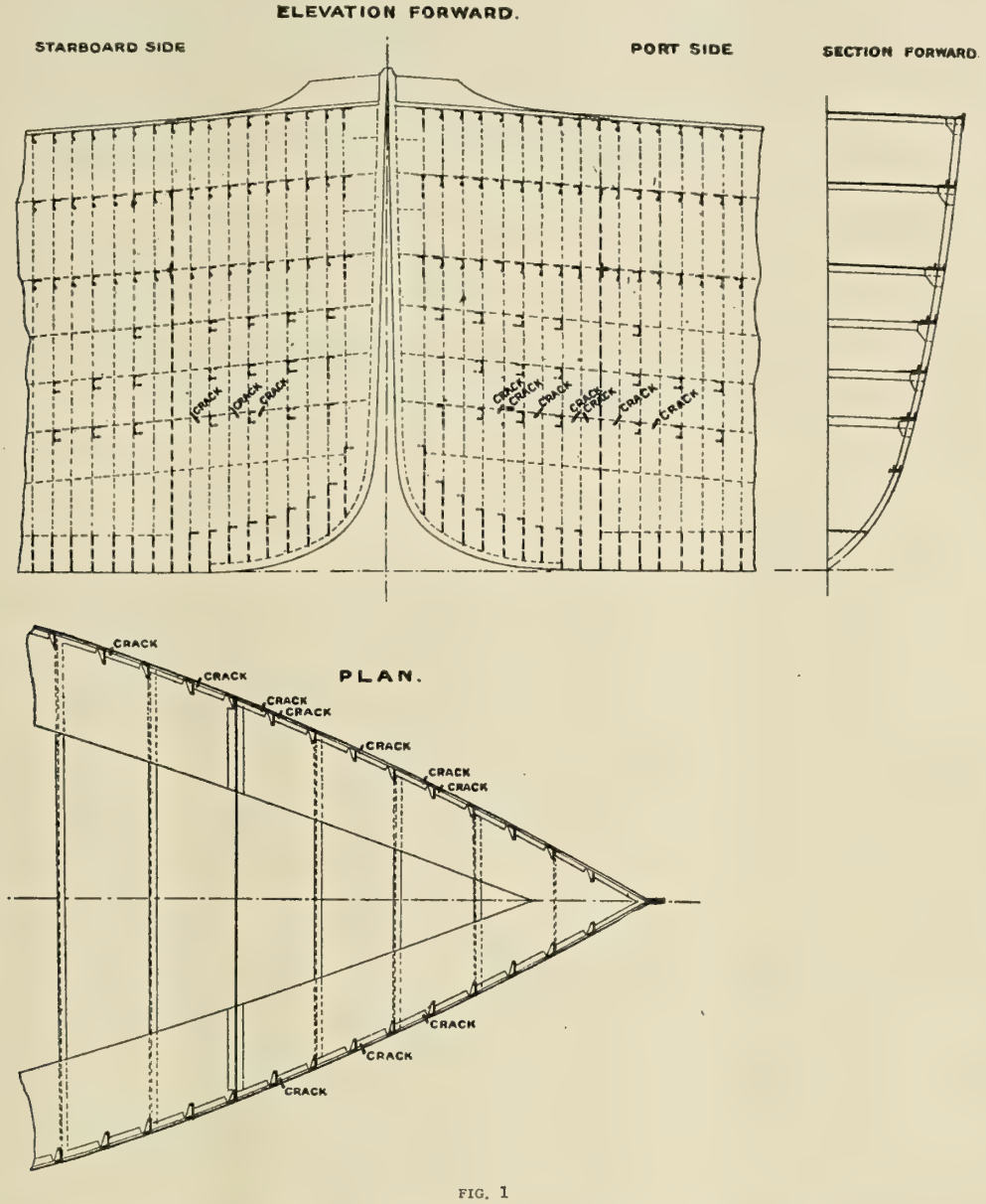


FIG. 1

In the first of these cases which came under notice a crack was observed in the shell plating on each side of a vessel a short distance forward of the collision bulkhead. These cracks extended right through the plating, and from the amount of wasting by corrosion which had taken place within the cracks it was evident that they were not of recent date. The cracks were of irregular form and did not break into rivet holes, nor were they near the edges of the plating. Soon afterwards another such case occurred, except that in this instance the cracks were at some short distance abaft the collision bulkhead. Then another and yet another case came under atten-

* Abstract of a paper read before the Institution of Naval Architects, Glasgow, June, 1913.

tion, so that surveyors at certain repairing ports began to look out for them when vessels came under survey. It was evident from the first to experienced surveyors that the symptoms were similar to those due to fatigue in the steel, such as had been observed at some other parts of vessels.

It was remembered that some twenty years ago similar cracks were sometimes seen in margin plates of double bottoms at the backs of the angle-bar attachments of the frame heel brackets. Leaks in the margin plate had led to the removal of the attachment angles, and then it was found that cracks had developed in the margin plate at the backs of these bars, in the vicinity of the uppermost rivet and sometimes near the rivet next to it. Such cracks were rarely joined to the rivet hole, but generally they partially encircled it, and it may be mentioned that they were mostly confined to No. 1 cargo hold.

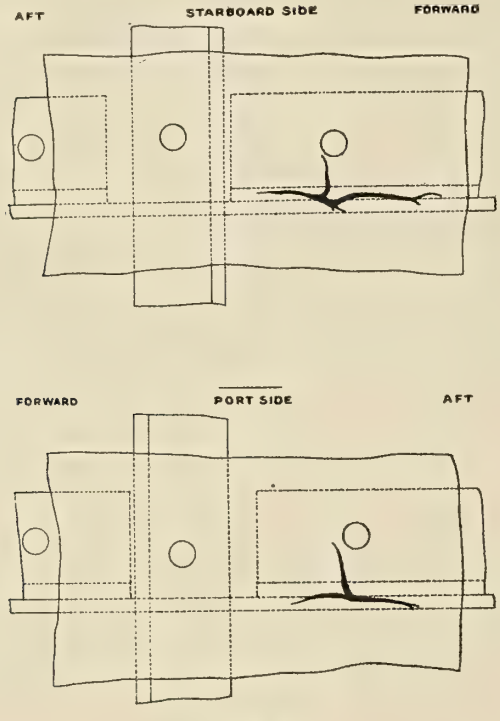


FIG. 2

Careful investigation showed that the cracks were the result of fatigue in the material of the margin plates, due to frequent alternating pull and push stresses brought upon the margin plate by the heels of the frames, and continued over a long period of time. The remedy was found in giving the frame heels a better connection to the double bottom, and this was effected by using double instead of single angle attachments at the margin plates, and by the more extensive use of gusset plates and angles in connecting the frames to the inner bottom plating. Instances of fatigue at this part of a vessel are not often seen at the present day, the remedies adopted having proved to be efficient for the purpose.

The cases in which the phenomena now under consideration had been observed were, therefore, analyzed, and it then appeared that they had certain features in common which pointed to a common cause, and consequently suggested a common remedy. It will be of interest to mention here that up to the date of writing this note about twenty-nine vessels have been found when under survey to have been affected in this way. These are all steamers, ranging from about 3,000 tons to about 5,000 tons gross register. Their ages, when they came under survey, ranged from two to sixteen years, the average age being about nine years. They are of all types, ranging from single-deck to three-deck, spar-deck and shelter-deck vessels, and some have web framing, while others are framed with the deep frames ordinarily adopted at the present day. There is nothing, therefore, as regards type of design or system of framing common to the vessels, but all of them are of steel. Moreover, they are the products of thirteen different builders and seven different building ports.

Fig. 1 shows the bow portion of the profile of one of the vessels, which may be taken as a sample of the total number. The same figure shows a sectional view of the vessel in way of the cracks, and also a part plan of the vessel. Fig. 2 shows some of the cracks on an enlarged scale.

From the positions of the cracks found in the shell plating of these vessels certain features will be apparent, and these, it may be remarked, are common to all cases. These features are as follows:

(1) The cracks are always found either in the forepeak or in the forepart of No. 1 cargo hold.

(2) They always occur at the back or at the edge of a chock angle attachment of a side or panting stringer plate to the shell plating.

(3) They always occur in close vicinity to a frame unsupported by a panting or other beam, and they never occur in the vicinity of a frame which is supported by beams.

This statement suggests at once the cause and the remedy. The primary cause is evidently slight local movement, frequently repeated and extending over a long period of time; and this slight local movement is also evidently due to something which distinguishes the frame at which it occurs from the adjacent frames; that is to say, in being unsupported. It will be observed by referring to the sketch that there cannot have been any panting in the structure itself, for the number of tiers of beams and panting stringers quite preclude such from taking place. The slight movement referred to has occurred only at the intermediate frames between those to which the beams are attached. Note also that, as in the case of margin plates, the crack occurs at the backs of the attachment angles but not at the rivet holes. The fatigue in the plate resulting in a crack seems, therefore, due to a slight but frequently repeated movement in the plating at the chock angle attachment. This suggests the necessity for securing the intermediate frames to the panting stringer and for distributing the resistance to panting stresses over a larger surface of shell plating. By attaching the intermediate frames (unsupported by beams) to a wide stringer plate by means of substantial brackets, and by substituting double for the single chock angle attachments of the stringer to the shell plating, it is hoped that an efficient remedy has been found for this trouble.

It may be added that both in the cases of fatigue at margin plates and in those described in this paper, tensile and other tests made upon material cut from the vicinity of the cracks do not show any abnormal conditions, but simply give the ordinary test results of good, mild steel used for shipbuilding purposes. This would seem to show that the effects of fatigue are practically limited to the small portion of the material which yields under its influence.

Launch of a Steel Screw Steamer at Stockton

On July 4, Messrs. Ropner & Sons, Ltd., Stockton-on-Tees, launched from their shipbuilding yard a steel screw steamer, christened the *Baldersby*, of the following dimensions, viz.: Length, 358 feet 6 inches; breadth, 50 feet 10 inches; depth, 25 feet 8 inches. The vessel will be classed 100 A-1 at Lloyd's, having main deck, poop, long bridge and T. G. forecastle. The appliances for loading and discharging cargoes expeditiously are very complete, and include ten steam winches, double derricks to each hatch, steam being supplied by a large donkey boiler, working at 100 pounds pressure per square inch. The engines will be of the triple-expansion type, by Messrs. Blair & Company, Ltd., Stockton-on-Tees, of about 1,500 indicated horsepower, having two steel boilers 16 feet by 10 feet 6 inches, 180 pounds pressure of steam.

The Deflection Method of Calculating the Strength of Columns and Stanchions—II

BY A. J. MURRAY

THE PARTICULAR CASE OF A STANCHION STAYED AGAINST A LATERAL PULL AT THE HEAD

In Fig. 5 a diagram of such a stanchion is shown, the forces being indicated. Suppose P is the total lateral pull at the head, then for equilibrium P = horizontal component of the resistance of the stays + the elastic resistance to bending the column.

If T = tension in stay.
F = elastic resistance of column.

Then by Fig. 5

$$P = T\ Sin\ \alpha + F \qquad (I)$$

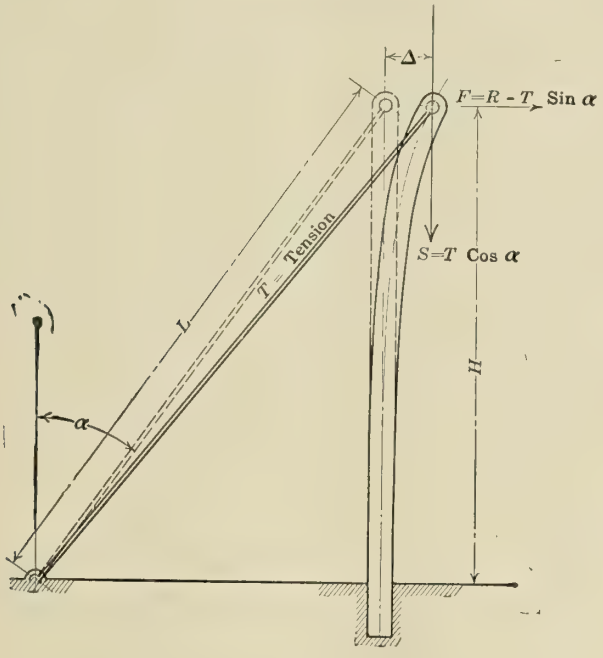


FIG. 5

For a small horizontal deflection Δ of the top of the stanchion, we have to a first order of small quantities.

$$T = \frac{\Delta\ Sin\ \alpha}{L} E_0 \qquad (II)$$

Where E_0 = coefficient of elasticity of stay and L = length of stay, the downward thrust on the stanchion is

$$T\ Cos\ \alpha = S \text{ (say)} \qquad (III)$$

Taking Δ as the deflection of the stanchion head, then the bending moment at a section, distant x from the foot, is given by

$$M_x = F(h-x) + S(\Delta - y) = EI\frac{d^2y}{dx^2}$$

where h = height of column.

The general solution is

$$y = A\ Cos\ nx + B\ Sin\ nx - \frac{Fx}{S} + \frac{Fh}{S} + \Delta$$

where $n = \sqrt{\frac{S}{EI}}$

To find the constants A and B

when $x = o$, $y = o$ therefore $A = -\left(\frac{Fh}{S} + \Delta\right)$

and when $x = o$, $\frac{dy}{dx} = o$, therefore $B = \frac{F}{Sn}$

When $x = h$, $y = \Delta$

$$\text{Therefore } \Delta = -\left(\frac{Fh}{S} + \Delta\right) Cos\ nh + \frac{F}{Sn} Sin\ nh + \Delta$$

$$\text{or } \Delta = \frac{F}{Sn} tan\ nh - \frac{Fh}{S}$$

$$\text{or } F = \frac{S\ \Delta}{\frac{tan\ nh}{n} - h} \qquad (IV)$$

Taking T = ultimate strength of the stay, then S is given by (III), *i. e.*, $S = T\ Cos\ \alpha$

Δ is given by (II), *i. e.*, $\Delta = \frac{LT E_0}{Sin\ \alpha}$

and $n = \sqrt{\frac{S}{EI}}$.

So that F is given by IV, and thus the greatest allowable pull is given by *I*, i. e., $P = F + T\ Sin\ \alpha$.

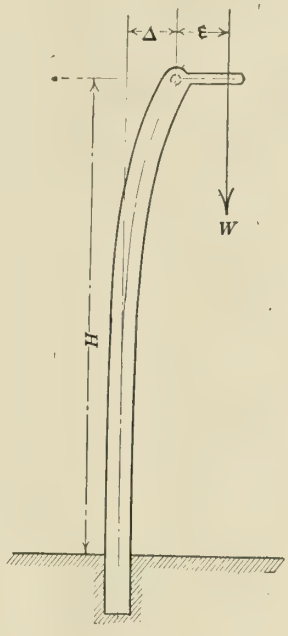


FIG. 6

We have proceeded on the basis of the maximum stress in the stay, and to find the necessary strength of the stanchion we have, bending moment at foot

$$M_0 = S\ \Delta + Fh.$$

If f is the ultimate strength of the column and A the area,

$$\text{then } f = \frac{S}{A} + \frac{Y}{I} M_0$$

$$= \frac{S}{A} + \frac{M_0}{Z} \qquad (V)$$

where Z is the modulus of the section of stanchion.

A method which is not absolutely rational, but gives the result in a more handy form, is as follows:

Consider the deflection curve to be one of versed sines

$$\text{i. e. } y = \Delta\left(1 - Cos\ \frac{\pi}{2h} x\right)$$

$$\left\{\text{where } x = o,\ y = o, \frac{dy}{dx} = o\right.$$

$$x = L,\ y = \Delta.$$

So that equation I is true at the cardinal points. Taking S and T as before, then

$$M_x = EI\frac{d^2y}{dx^2} = S\left[\Delta - \Delta\left(1 - Cos\ \frac{\pi}{2h} x\right)\right] + F(h-x)$$

$$= S\ \Delta\ Cos\ \frac{\pi}{2h} x + F(h-x)$$

and integrating out

$$F = \frac{3\,\Delta}{h^3}\left(E\,I - \frac{4\,sh^2}{\pi^2}\right)$$

and the maximum bending moment is

$$M_s = \frac{3\,\Delta}{h^2}\left(E\,I - \frac{4\,sh^2}{\pi^2}\right) + S\,\Delta$$

Therefore,

$$M_0 = \frac{L\,T}{E_0\,Sin\,\alpha}\left(\frac{3\,E\,I}{h^2} - \frac{12\,T\,Cos\,\alpha}{\pi^2} + Cos\,\alpha\right)$$

So that if f = ultimate strength of the column material, and Z = modulus of section at foot, then

$$f = \frac{T.Cos\,\alpha}{A} + \frac{L\,T}{E_0 Z\,Sin\,\alpha}\left(\frac{3\,E\,I}{h^2} - \frac{12\,T\,Cos\,\alpha}{\pi^2} + Cos\,\alpha\right)$$

This expression gives at once a relation between the strength of stanchion and strength of stay, so that having either the scantlings of the stanchion or stay, we can proceed to make the other of equal breaking strength, so that neither be too strong nor too weak.

Another advantage of this latter method is that if the cross section is not uniform we can set up a curve of $\frac{M_x}{I}$ and carry out the process of integration graphically.

In such cases as a stayed derrick, the pull of the topping lift can be resolved into its horizontal and vertical components and by adding the vertical component to the force S in the above expression, the method of procedure would then be exactly as described for the case of a horizontal pull above.

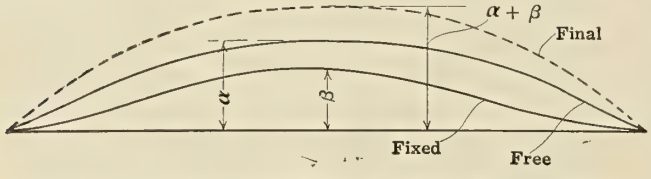


FIG. 7.—A + B EQUALS DEFLECTION AT MIDDLE OF FINAL CURVE

The Particular Case of an Unstayed Stanchion Bearing a Load on the Top

Assuming, as in the case of round-ended columns, that there is an eccentricity of loading, we have (Fig. 6):

$$\frac{d^2y}{dx^2} = M_x = W\,(\Delta - y) + W\epsilon$$

where ϵ = eccentricity of loading, Δ = deflection of top of stanchion.

Integrating as before, $y = A\,Cos\,nx + B\,Sin\,nx + W\,(\epsilon + \Delta)$

where $n = \sqrt{\frac{W}{E\,I}}$

whence $\Delta = \epsilon\,(Sec\,n\,L - 1)$.

Taking p as the direct stress due to load only, and f the maximum fiber stress, then

$$f = p\left(1 + \frac{y\,\varepsilon}{\gamma^2}\,Sec\,n\,L\right)$$

$$\text{or } Cos\,R\sqrt{\frac{p}{E}} = \frac{y\,\varepsilon}{\gamma^2}\cdot\frac{p}{f-p}$$

It should be noted that if we here put $\epsilon = o$, we obtain

$$R^2 = \frac{\pi^2}{4} \times \frac{E}{p},$$

which is Euler's expression for an ideal column fixed at the foot and unsupported at the head.

In many cases the eccentricity ϵ has a definite value, being, in fact, the overhang of the load. For instance, in the case of a davit, if we suppose the curved portion replaced by a right-angled bend then both the deflection and stress are given by the above expressions. Usually the deflection of boat and other davits is not figured out, but we find that for some modern warship davits the horizontal deflection at the top reaches some 3 or 4 inches. With such an elastic deflection the whipping would cause the load to be exceedingly lively.

Fixed Ended Columns

Euler's formula for fixed ended columns gives much too high results, and the length for which the formula becomes practicable is much greater than that for free ends. It can therefore only be considered as of theoretical interest, and as giving the limiting value for the load for very high values of $\frac{L}{\gamma}$.

Rankine's formula for fixed ended columns is derived from Euler's formula in the same way as for free ended columns, and gives a fair approximation but no satisfactory means of passing from one material to another.

Moncrief's formula for fixed ended columns cannot be considered as satisfactory, as the eccentricity factor has no meaning at all, since eccentricity of loading does not increase the bending moment at the middle of a fixed ended column.

Further, no respectable column would agree to contort itself into the weird curve he derives by joining up three separate parabolas.

If it is impossible to exactly centralize the load; it is equally impossible to absolutely fix the ends of a column.

Let us suppose, then, that the constraint is not absolutely perfect, and that the deflection curve may be taken as composed of a curve of versed sines, with a superimposed curve of sines, the former taking account of the constraint and the latter of the small degree of freedom.

Fig. 7 shows the method of obtaining the deflection curve. The tangents at the ends will be slightly inclined to the axis.

Let $y_1 = \beta\,Sin\,\frac{\pi}{L}\,x$

represent sine curves.

$$y_2 = \frac{\alpha}{2}\left(1 - Cos\,\frac{2\pi}{L}\,x\right)$$

curve of versed sines. The final curve is given by

$$y = y_1 + y_2 = \frac{\alpha}{2}(1 - Cos\,2\,n\,x) + \beta\,Sin\,n\,x$$

where $n = \frac{\pi}{L}$

The total deflection at the middle is given by

$$\Delta = (\alpha + \beta).$$

The tangent at the bottom ($x = o$) is given by

$$\frac{dy}{dx} = n\,\beta.$$

At the top

$$(x = L)\text{ by } \frac{dy}{dx} = -n\,\beta.$$

If M_0 is the bending moment at ends, due to constraint, then

$$M_x = Wy + M_0,$$

$$\text{or } -E\,I\,\frac{d^2y}{dx^2} = W\left[\frac{\alpha}{2}(1 - Cos\,2\,n\,x) + \beta\,Sin\,n\,x\right] + M_0$$

$$\text{Intergrating } -E\,I\,\frac{dy}{dx} = W\,\frac{\alpha}{2}x + M_0\,x - \frac{W\alpha}{4\,n}\,Sin\,2\,n\,x - \frac{W\,\beta}{n}\,Cos\,n\,x + A$$

$$-EIy = \frac{W\,\alpha\,x^2}{4} + \frac{M_0\,x^2}{2} + \frac{W\,\alpha}{8\,n^2}\,Cos\,2\,n\,x - \frac{W\,\beta}{n^2}\,Sin\,n\,x + A\,x + B$$

$$\text{where } x = o \begin{cases} y = o \text{ therefore } o = \frac{W\alpha}{8n^2} + B \text{ or } B = -\frac{W\alpha}{8n^2} = -\frac{W\alpha L^2}{8\pi^2} & (1) \\ \frac{dy}{dx} = n\beta \text{ therefore } EIn\beta = -\frac{W\beta}{n} + A. A = \frac{W\beta}{n} \\ \qquad - EIn\beta & (2) \end{cases}$$

$$\text{when } x = L \begin{cases} y = o.\ o = \frac{W\alpha L^2}{4} + \frac{M_o L^2}{2} \div \frac{W\alpha}{8n^2} + AL + \beta & (3) \\ \frac{dy}{dx} = -n\beta.\ EIn\beta = \frac{W\alpha L}{2} + M_o L + \frac{W\beta}{n} + A & (4) \end{cases}$$

$$\text{when } x = \frac{L}{2} \begin{cases} \frac{dy}{dx} = o;\ o = \frac{W\alpha L}{4} + \frac{M_o L}{2} + A & (5) \\ y = \Delta, -EI\Delta = \frac{W\alpha L^2}{16} + \frac{M_o L^2}{8} - \frac{W\alpha}{8n^2} - \frac{W}{n^2} + \frac{AL}{2} \\ \qquad + \beta & (6) \end{cases}$$

From (1), (2) and (5):

$$\frac{M_o L^2}{8} + \frac{AL}{2} = \frac{W\beta L}{4n} - \frac{W\alpha L^2}{16} - \frac{EIn\beta L}{4}$$

Substituting n (6):

$$-EI\Delta = \frac{W\alpha L^2}{16} - \frac{W\alpha}{8n^2} - \frac{W\beta}{n^2} - \frac{W\alpha}{8n^2} + \frac{W\beta L}{4n} - \frac{W\alpha L^2}{16} - \frac{EIn\beta L}{4}$$

$$\text{or } EI\Delta = \frac{W\alpha}{8n^2} + \frac{W\beta}{n^2} + \frac{W\alpha}{8n^2} - \frac{W\beta L}{4n} + \frac{EInL\beta}{4}$$

$$= \beta\left(\frac{W}{n^2} - \frac{WL}{4n} + \frac{EInL}{4}\right) + \alpha\frac{W}{4n^2} \qquad (7)$$

If in (7) we put $\alpha = o$, we get Euler's expression for free ends, *i. e.*, $W = \frac{EI\pi^2}{L^2}$, and if we put $\beta = o$, we get Euler's expression for fixed ends $W = \frac{4EI\pi^2}{L^2}$.

$$\text{Sine } \alpha + \beta = \Delta$$
$$\alpha = \Delta - \beta,$$

and we have.

$$EI\Delta = \beta\left(\frac{W}{n^2} - \frac{WL}{4n} + \frac{EInL}{4}\right) + \frac{W}{4n^2}(\Delta - \beta)$$

$$\text{or } \Delta\left(EI - \frac{W}{4n^2}\right) = \beta\left(\frac{W}{n^2} - \frac{WL}{4n} + \frac{EInL}{4} - \frac{W}{4n^2}\right)$$

$$\text{or } \Delta = \frac{\beta\left(\frac{W}{n^2} - \frac{WL}{4n} + \frac{EInL}{4} - \frac{W}{4n^2}\right)}{EI - \frac{W}{4n^2}}$$

Substituting the value $n = \frac{\pi}{L}$

$$\Delta = \frac{\beta\left(\frac{3}{\pi^2} + \frac{EI\pi}{WL^2} - \frac{1}{\pi^2}\right)}{\frac{4EI}{WL^2} - \frac{1}{\pi^2}}$$

or putting

$$\frac{L}{i} = R$$

$$\Delta = \frac{\beta\left(\frac{2}{\pi^2} + \frac{E\pi}{pR^2}\right)}{\frac{4E}{pR^2} - \frac{1}{\pi^2}} = \frac{\beta(2pR^2 + E\pi^3)}{4E\pi^2 - pR^2} \qquad (8)$$

If f be the maximum compression fiber stress at the middle section of column when p is the average load per unit area, then

$$f = p + \frac{My}{I}$$

$$= p + \frac{y}{I} W\Delta = p + \frac{yp}{\gamma^2}\Delta$$

and substituting the value of Δ from equation (8),

$$f = p\left[1 + \frac{y}{\gamma^2}\ \beta\left(\frac{2pR^2 + E\pi^3}{4E\pi^2 - pR^2}\right)\right]$$

$$\text{therefore}\left(\frac{f}{p} - 1\right)(4E\pi^2 - pR^2) = \gamma(2pR^2 + E\pi^3)$$

$$\text{where } \gamma = -\frac{y\beta}{\gamma^2}$$

$$\left(\frac{f}{p} - 1\right)4E\pi^2 - E\pi^3 = \gamma 2pR^2 + pR^2\left(\frac{f}{p} - 1\right)$$

$$= R^2(2\gamma p + f - p)$$

$$R = \sqrt{\frac{E\pi^2\left[\left(\frac{f}{p} - 1\right)4 - \gamma\pi\right]}{2\gamma p + f - p}} \qquad (9)$$

If γ is put equal to zero, then this expression for the stress p returns to Euler's for fixed ends.

For mild steel columns of 60,000 pounds, experiment gives $\gamma = .32$.

$$R = \sqrt{\frac{2561\left[4\left(\frac{6-p}{p}\right) - 1\right]}{.64p + (6-p)}}$$

p being in units of 10,000 pounds.

Proposed Memorial to the Late Sir William White

A meeting was recently held at the Institution of Naval Architects, with Sir Philip Watts, K. C. B., F. R. S., in the chair, to consider what steps should be taken to establish a memorial to the late Sir William White. Representatives of the principal engineering and allied institutions with which Sir William White was connected attended this meeting, and it was resolved to form an influential general committee representing the naval and merchant services, as well as the engineering profession, in order to carry out the object in view. Promises of financial support and communications relating to the proposal will be gladly received by Mr. R. W. Dana, M. A., the secretary of the Institution of Naval Architects, 5 Adelphi Terrace, W. C., who is acting as honorary secretary to the provisional committee.

Accident to the Louisiana

The bravery of the engine room crew of the battleship *Louisiana* helped the vessel out of a dangerous predicament July 2, when a valve bonnet blew off, flooding the starboard engine room.

The battleship was in Narragansett Bay overhauling her engines. The rush of the sea through the passage opened by the displacement of the bonnet carried men off their feet and forced them against the machinery, but they stuck to their work.

The call for collision drill was sounded, bringing every man aboard ship to quarters and automatically closing the bulkhead doors. A collision mat was put overboard, mattresses and blankets were brought into use, and waste in large quantities was jammed into the hole, but all to no avail.

Finally the pumps began gaining on the water in the room, and the battling engine-room force was able to cram into the hole a waste can, heavily packed. This was backed securely, and the threatening water was stopped.

When the accident occurred the battleship was without steam, only one boiler being in use for minor purposes, while the engines were being overhauled.

As a result, tugs had to be called upon to tow the *Louisiana* to a position well inshore. So close was the battleship to the beach that it was reported on shore that she had actually been run upon the sand. Later through the efforts of a diver a new bonnet was placed on the auxiliary overboard discharge valve, through which the water had rushed, the engines were started, and the battleship steamed back to her station without help. —*Army and Navy Register.*

United States Destroyer Duncan

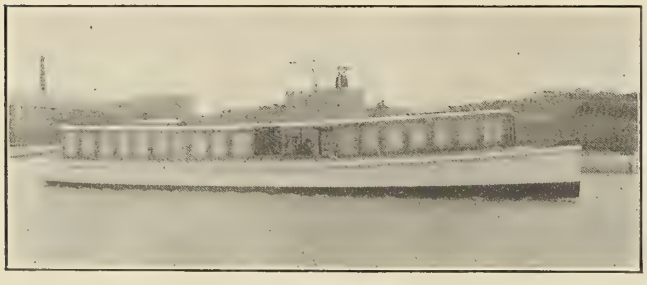
The United States torpedo boat destroyer *Duncan,* 305 feet 3 inches long over all, 30 feet 6 inches beam, fitted with Curtis turbines, developing 16,000 horsepower on twin screws, recently left the works of the builders, the Fore River Shipbuilding Company, Quincy, Mass., for the navy yard, Boston, where she was placed in drydock for overhauling preparatory

DESTROYER DUNCAN LEAVING BUILDER'S WORKS FOR TRIAL RUNS

to her standardization trials, which began on July 5 over the Rockland (Maine) course. For the purpose of improving the economy under cruising conditions a compound reciprocating engine is connected by means of a removable clutch to the forward end of the turbine shaft. The steam after passing through the engine exhausts into the turbine, which acts as a low pressure unit under this condition. The vessel will be delivered to the Government early in August.

Passenger Motor Boat for South America

J. W. Brooke & Company, Ltd., Lowestoft, recently shipped to South America a 60-foot passenger motor boat built of teak of heavy section, designed to ply between two ports in an open river. Accommodations, divided into first and second class cabins, are provided for 100 passengers. The motive



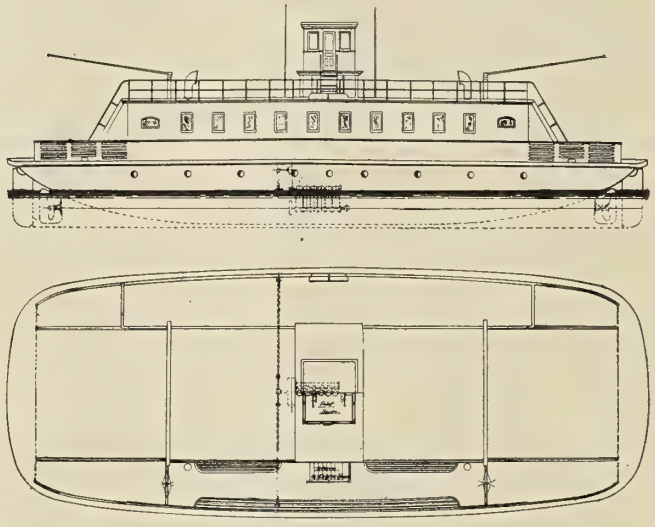
60-FOOT, 11-KNOT PASSENGER MOTOR BOAT

power, which is situated amidships, consists of two 45-horsepower, four-cylinder Brooke motors, with heavy type, single-lever Brooke epicyclic reverse gear, with the two engines driving right and left-hand propellers. The control and steering gear is carried on the upper deck, while right forward of the first class cabin is a forecastle fitted up for the accommodation of the crew. The lighting of the boat is effected by a dynamo driven from the port engine charging accumulators through an automatic switch. On trial the speed of the boat proved to be just over 11 knots.

Motor Ferryboat

A 96-foot ferryboat has recently been built the motive power of which is furnished by a 125-horsepower Standard air-starting and reversing engine. The hull of the vessel is 96 feet long over all, 37 feet 6 inches beam extreme over guards, and 5 feet draft, with accommodations for 100 passengers together with twelve automobiles or the equivalent. The general arrangement of the boat is shown by the illustration.

The adaptability of this form of motive power for a boat of this type is evident from the fact that the engine starts, stops



96-FOOT FERRYBOAT PROPELLED BY 125 HORSEPOWER STANDARD MOTOR

and reverses on compressed air, fed into the cylinders in such a way that it does not interfere in any way with the gas cycle of the engine. The engine is operated from a single point by the shifting of the cam-shaft lever. Owing to the fact that fuel is consumed only during the actual time that the engine is running, this form of motive power brings about a considerable saving in fuel over that required by steam machinery in a ferryboat of this size. The engine is a six-cylinder motor, 8½ inches bore and 11 inches stroke, weighing approximately 5,800 pounds. Engines of this type usually run at a speed of between 350 to 400 revolutions per minute, the actual power developed ranging from 130 to 180 brake horsepower.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 178 sailing, steam and unrigged vessels of 36,729 gross tons built in the United States and officially numbered during the month of June. Of the total number of vessels built, 7, aggregating 15,968 gross tons, were steel steamships built on the Atlantic coast; 4, aggregating 4,694 gross tons, were steel steamships, built on the Pacific Coast, and 2, aggregating 3,203 gross tons, were steel steamships, built on the Great Lakes. The largest vessel completed during the month was the *Congress,* of 7,985 gross tons, built by the New York Shipbuilding Company, Camden, N. J., for the Pacific Coast Steamship Company. The next largest was the *Richmond,* of 6,563 gross tons, built by the Fore River Shipbuilding Company, Quincy, Mass., for the Standard Oil Company, of California.

New Steamships for the River Plate Trade.—Two new steamers of the Lloyds Royal Holland Line, *Gelria* and *Tubantia,* have lately been launched for the River Plate trade, both of 14,500 tons and a speed of 17 knots. Each will carry 250 first-class, 225 second-class, 140 special third-class, and 900 ordinary third-class passengers. They will sail from Amsterdam for Montevideo on October 1 and December 2, 1913.

Electric Welding

BY CHARLES A. GRAMS, M. E.

Autogenous welding is a system of uniting metals by means of soldering them with a metal of the same composition as the metals to be welded. In marine work at the present day the method of welding is used most extensively on repairs to shafts, boilers, condensers, piston rods, etc., and even broken propellers have been welded, as have also the plates of steel ships.

It is well to have every large ship equipped with a welding outfit. The cost of same is not exorbitant and a special operator is not necessary, as a member of the ship's engine crew can learn to use the apparatus in a short time and become very proficient with it. The time saved by one operation sometimes more than pays for the cost of the apparatus, and the reduced cost of making repairs is another great consideration.

Years ago, in a great many cases, the breaking of the ship's shaft necessitated the hauling of the ship on the ways or in dry dock, where it remained until a new shaft had been made and installed, but in some cases a coupling was made to connect the two broken parts. The method of using a coupling of this character is efficient in some cases, but the method of welding is by far the best.

After a shaft has been welded, as an extra precaution against a break of the weld, a coupling is sometimes also used over the welded part. This should be done only in case of a shaft of great diameter, as a weld on such a shaft may not be done in a thorough manner by some new operators; but there is no great necessity for this.

In the process of welding a broken shaft the ship does not have to be dry-docked, but can be in the process of loading or unloading while the repairs are being made. In several instances certain repairs have been made while a ship was on the seas, but in most cases it is best to weld while there is no vibration of any kind to disturb the separate parts, as in several tests it was found that welds made where there was no vibration whatever showed a slightly greater strength than where just a slight vibration occurred. In most cases, however, no vibration occurs to move the parts, and the weld can be made without any fear of a further break.

Repairs have been made where the operator has had very little work room, where he was cramped and hampered; but as very little room is needed, and as most breaks occur where they can be easily reached, trouble from this source is very little heard of.

There are several methods of welding by use of the electric arc, all of which have their advantages, but the system in most general use and which requires the least skill in operation is known as the Bernardos system. In the Bernardos system an installation of a 75-kilowatt plant, 125 volts and 600 amperes is desirable, but for large and extra heavy work an installation of a 100-kilowatt plant is preferable.

A system of control is essential, as no two welds require the same current strength either in volts or amperes. The water barrel is the most commonly used form of resistance but also the least efficient method, the heating of the water causing a change constantly in the resistance, and consequently in the strength of the current. On this account the water-barrel system is not very satisfactory, and while the gridiron method of resistance is even better the cost of installation is somewhat greater.

In the first method the water barrel is installed in series with the positive pole, and the material to be welded is so adjusted as to consume about 40 percent of the potential strength, 60 percent going to the arc. In most installations there are three barrels connected in multiple, and in case of one weld being on a large section and another on a smaller section, one or more of the barrels can be cut out, and the field rheostat of the dynamo so adjusted as to raise the voltage to the required arc.

The grid in its operation is more even, and when connected with a series of switches, which throw out some of the line resistance as the arc is formed, and throw a certain load on the dynamo when the arc is cut out, will prevent a great and sudden range of load which would cause serious damage to the apparatus. The resistance also prevents the short circuiting of the dynamo by the operator forming the necessary contact or by carelessly allowing the carbon to stay in contact with the welded parts. This has been remedied to a certain extent by installing in the tool a switch which automatically opens the current when released of pressure.

The positive wire is connected to the part to be welded, for the potential reason that a great deal of harm sometimes comes about by the hardness of the weld and the strains set up when the weld cools and shrinks. The hardening is induced by the absorption of carbon from the dioxide of the consumed carbon electrode and the sudden cooling of the heated part. Connecting the positive wire to the part to be welded causes the current to flow from the iron to the carbon and the gases, etc., forced away from the iron instead of to the iron, as would be the case were the flow from the carbon to the iron. It is always best to anneal or cool the welded part slowly to overcome the trouble caused by sudden cooling.

In electrical welding, as in fire welding, it is advisable to use a flux, which acts chemically and absorbs to a certain extent all gases and also prevents slagging in the weld. The flux is applied by sprinkling same over the added metal while the welding is in process.

The Bernardos system, just described, is the most widely known and used system of autogenous welding by the use of the electric arc, but it is by no means the only efficient system in existence. To overcome the defects of the Bernardos system and to eliminate the carbon from the weld, a system making use of a metallic electrode is known as the Slavianoff system.

In this method the same proportional resistance is essential and advisable, but a more even control is desirable. To secure this control only the best alloy wires should be used in the apparatus. The Slavianoff system requires less voltage than the other system. Fifty volts and 165 amperes give the best results on any section to be welded. The current is also divided so as to give 40 percent of the potential strength in the resistance and 60 percent to the arc.

In the Bernardos system the break to be welded is filled with pieces of metal, and these pieces by coming in contact with the negative electrode melt and fill up the cavity, at the same time soldering it. The piece to be welded can only be operated upon from the upper side. On the other hand, in the Slavianoff system the negative wire is attached to the part to be welded and the positive wire terminates in a holder which contains a rod of the same metal that is to be added to the broken piece. By making a contact with the piece and withdrawing it a slight part of an inch an arc is formed, and the end of the rod is fused and the metal from same enters the cavity until the entire rod is consumed and the operation is repeated until the cavity is filled. By this system the metal can be deposited on the metallic surface in most any position, but only steel and wrought iron can be worked on from the under side. As several metals are of a fluid nature when heated they can only be operated upon from the upper side. The size of the rod of welding metal is usually of three-sixteenths or four-sixteenths of an inch in diameter and of any convenient length.

The Slavianoff process is much slower than the Bernardos system, but it is much more reliable and the trouble of the hard welds is entirely dispensed with. Great skill is required to maintain the correct arc, owing to the fact that the welding metal has a tendency to stick to the part to be welded if brought in too close contact, and if held too far away the arc ceases;

therefore it requires considerable time to instruct new operators in maintaining the correct arc.

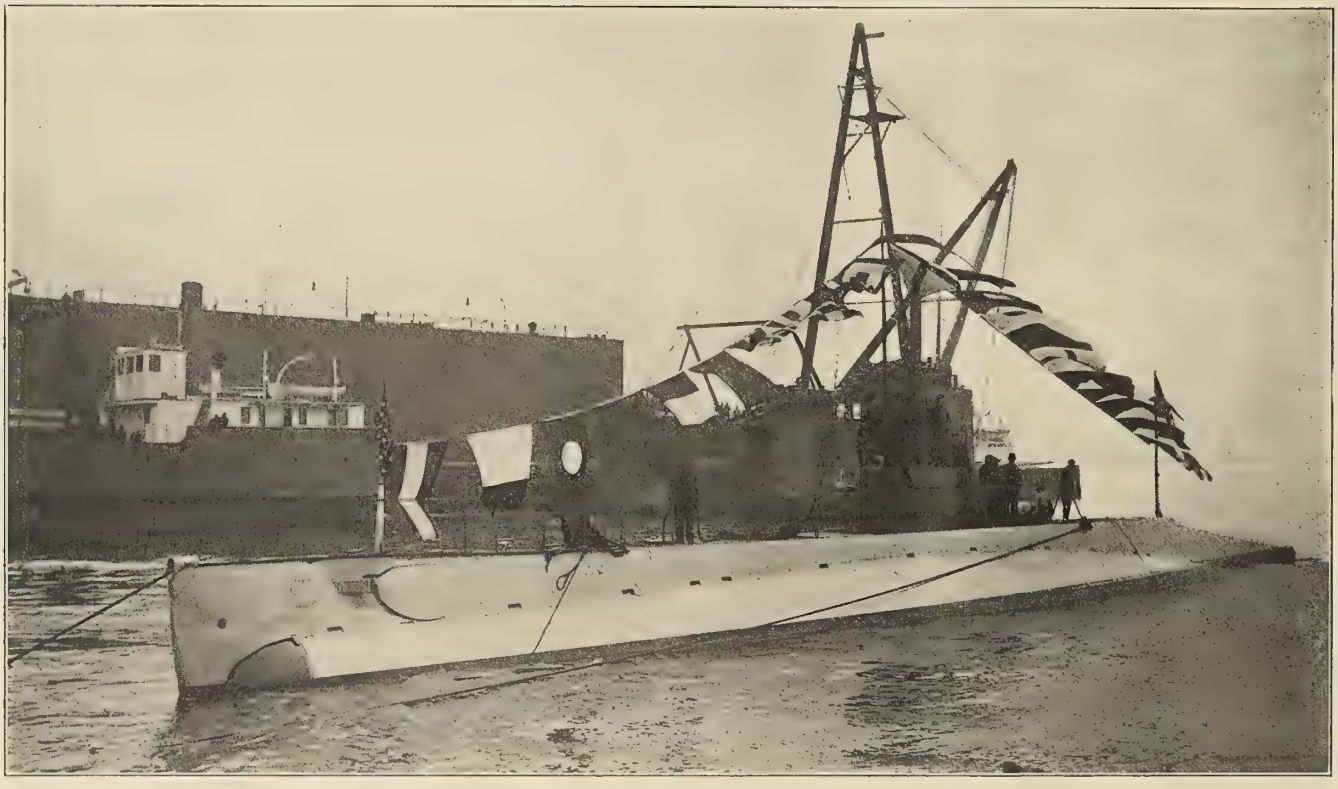
In this process the rate of deposition of the rod of welding metal to the surface operated upon does not exceed 8 cubic inches per hour, and when working on the under side of the surface does not exceed 6 cubic inches per hour. While this process is somewhat slower than the Bernardos process the weld possesses a much more even and smoother finish.

The Slavianoff process is adapted to the repairs of marine boilers in particular, and in Europe, about the Baltic, it is as common as is the oxy-acetylene process in America.

The Zerener process, the invention of a Swiss engineer, is also known as the electric torch process from its similarity to the oxy-acetylene torch. This process is in very little use, extensively on very thin substances, where neither of the other systems is applicable.

In all cases of welding, especially on cast iron, it is always best to heat the parts to be welded somewhat before starting operations, but no general rule of preheating is applicable to all cases, most operators understanding just at what temperature the best weld can be made.

In every series of tests made as to the relative strength of the electric weld and the fire-welded object, it was found that the electrically-welded object was the stronger of the two. As autogenous welding is still in its infancy, we may look forward to the time when it will be in general use, and where the strength of all welds will almost equal the original strength of the piece welded.



LAUNCH OF THE UNITED STATES SUBMARINE H-3 AT SEATTLE, WASH.

owing to the hardness of the finished weld, due to the nature of the flame, which occurs between two carbon electrodes, and is directed downward by a series of magnets set in series with the welding current, although in Switzerland and France it is used to a certain extent.

This system requires a voltage of 85 and 20 amperes, and the output of the welding is extremely small. It is, however, satisfactorily used on light brass objects—zinc, lead and thin iron plates—especially in the trades dealing with stamped steel. the greatest disadvantage being in the extreme hardness of the weld.

In all three systems mentioned there is some drawback, and the use of these systems may be summarized as follows:

The Bernardos system is the best system to use in all work where great strength or fine finish are not desirable, such as the filling of defective castings, etc. The Slavianoff system is the best to use where smoothness of finish and strength are essential, such as the welding of broken shafts, boiler plates and in general marine work. The Zerener system is used most

As the actinic ray is very active in electric welding, and the brightness of the light detrimental to the vision, the operator's body must be protected. The usual method of protecting the head and face is to cover same with a hood with an opening in same for the eyes. This opening is so constructed that pieces of red and green or blue glass may be inserted. It is best to insert a piece of yellow glass between the other two, as this neutralizes the ray of the arc, which is so detrimental to the vision. The hands are covered by leather gloves, while the clothing is sufficient protection for the rest of the body.

LAUNCH OF U. S. SUBMARINE H-3.—An event significant in the development of Pacific Coast naval defenses took place on July 3 at the plant of the Seattle Construction & Dry Dock Company, at Seattle, Wash., when the new submarine H-3 was successfully launched. Another submarine, the K-4, is now building at the same plant, and it is expected that its launching will occur early in the fall.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Repair of a Fractured Feathering Eccentric

The *P*—— *S*—— was taking a pier when the float to which the driving arm was attached struck a log of wood, with the result that a corner of the wooden float was broken off and the eccentric fractured as shown at *A* in sketch. A spare eccentric was not handy at the moment, so the following temporary repair had to be effected: A piece of wrought iron plate 1 inch thick was obtained and cut roughly to the shape of the eccentric and a hole bored in it to go over the "jinny nettle" bracket. The radius rod pins were then dressed down

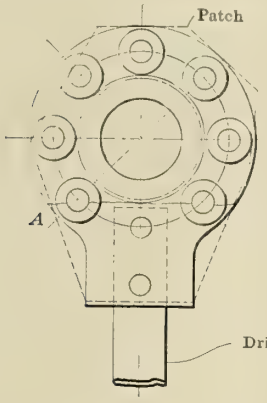


FIG. 1

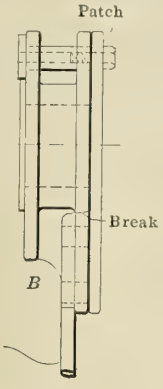


FIG. 2

flush with the eccentric and the holes through their centers tapped to take ⅞-inch pins. The bolts holding the driver in position were removed and longer ones substituted to go through the eccentric, driving arm and plate. The plate was bored to suit these holes and the holes in the radius rod pins, the plate being then bolted and pinned in position, as shown in the sketch. This repair answered admirably until a new eccentric could be obtained, when the old one was removed and the new one substituted. In order to minimize the risk of breakage the new eccentric was made with webs carried on to the other flange, as shown by the dotted lines at *B*.

Glasgow. "Ison."

The Value of Life-Saving Appliances

Some months ago you kindly published a letter from me with reference to this important question. Since then I am glad to say it has made marked progress, and is now receiving that attention from the Board of Trade and the great shipping companies which it deserves. Some three or four factories are now engaged in manufacturing the latest ideas of inventors, which should quickly replace the antiquated lifebuoys, belts and other contrivances which have too often proved ineffective in the past. The Cunard, P. & O., Orient and Atlantic Transport lines have each realized the importance of bringing their outfits up to date, and have given an admirable lead in this direction. It is, however, well known that it is among the small ship owners that the greater apathy prevails, and as this question is so vital a one to many of your readers I am writing this in the hope that they will use every endeavor to make their influence felt. During the summer the provision of modern appliances is a duty laid on the owners of excursion steamers, members of corporations who control sea bathing, riverside risks and so on, for which they owe a great responsibility to the public. The Board of Trade have done their part to some extent by calling attention to the needs of shipping, and, to use an admirable expression from across the Atlantic, it is "up against" other public bodies to do their part.

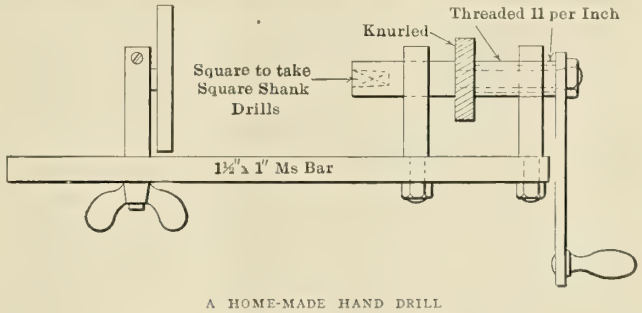
Another and more potent argument will, unfortunately, be supplied by the chronicle of fatalities to be found in nearly every newspaper in this water-loving island during the summer months, many of which might have been averted had an adequate equipment of these recent inventions been at hand, as they cover risks to children as well as adults. Attention is rightly concentrated on the courage which is evinced throughout the country at times of such dangers and rewarded by the medallions of the Royal Humane Society. It would be an equally worthy action if the benevolence of the public showed itself by providing these safeguards at all places not already dealt with by shipping owners or public bodies.

London. John Holland.

Hand Drilling

In any comparison of drilling operations, or any analysis of it as an operation, the outstanding feature is that the pressure required for feed is considerable when considered in relation to the power required to turn the drill.

Some experiments conducted by one firm known to me, using a quite ordinary column drill specially rigged for the occasion, proved the downward pressure needed for a 1-inch twist drill to be approximately 4 tons. This explains the inefficiency of the usual type breast drill, the operator having to



A HOME-MADE HAND DRILL

exert very considerable pressure with his body on quite a small hole.

Drilling with a ratchet, the alternative to the above, is a clumsy operation for small holes. A breast drill is ineffective for holes larger than ¼ inch in cast iron, while to have to rig a gooseneck for a ½-inch hole is a nuisance, especially if the job is small.

Using a ratchet brace, the downward pressure required is minimized by the selection of the shape of drill. From experience of shipyard drillers on piecework, there is more in the shape than meets the eye. Rigging afresh for each 4 holes drilled, 144 ¾-inch holes through M. S. plate ⅝-inch thick in eight hours is a normal output. The price paid was 1 shilling (25 cents) per dozen holes. Each man owns his own ratchet brace, which he brings along to the job. The braces used are

of the type carrying a guide sleeve to feed the nut, the screw being totally inclosed from view.

Twist drills are never used. Each man's output would go down 25 percent, it having been tried. Preference is toward a flat smith-made drill having the cutting edge lipped. This is done by placing the edge of the drill on the edge of an anvil while hot, and so giving the edge a cutting rake by means of a blow. Such a drill sinks itself into the metal with the slightest touch of the hand on the feed nut of the ratchet.

On one job 30 drillers were engaged for a month's work. They brought their own smith along, who had to be paid by the yard doing the job, and also a man to fetch and grind drills. Both of these had to be acceptable to the men before they would start.

It shows how discriminating a man becomes when working piecework and using human muscle (his own) for motive power.

Such discrimination is ordinarily a proof of a good workman. A bricklayer purchasing a new trowel and a navvy selecting a shovel are amusing instances of this when witnessed for the first time. Neither would lend his tools for any consideration. The condition of a man's tools is a good index both as to character and efficiency. The first question asked an applicant for employment at several firms known to me is if he possesses a "mike"; this in spite of the fact that in two instances the work done is not of a character making this necessary.

Probably the handiest single tool carried round by a seagoing engineer of my acquaintance is a rather clumsy-looking home-made drill. The sketch shows this tool. The main portion is a piece of 1½-inch by 1-inch bar. It is fitted with two brackets carrying a spindle, which portion may be termed the head stock, and a similar loose bracket which might be called a tail stock. The 1½-inch by 1-inch bar has ½-inch holes pitched 1 inch apart and the tail stock slips into these.

In use the bar is gripped in the vice, and the jobs possible to such a primitive-looking contrivance are many. It will drill ⅝-inch holes from the solid and will open same out to 1 inch without difficulty. Personally I have bored out winch brasses by its aid, doing some juggling to set same up fair.

The contrivance takes care of end pressure which a breast drill cannot do. With two centers, some primitive turning has been successfully accomplished by its means, using the vice jaw as a rest and gripping the device at the lowermost point of vice jaws. Naturally it has limitations which are obvious, but before criticism is passed it is necessary to give it a trial.

Its capabilities are many, and I think its owner would sooner part from his beard, of which he is inordinately proud, rather than lose his home-made contrivance. It was made at sea, the brackets filed up from the solid, the spindles were made from annealed round files, the bar was dressed up with a file and the holes drilled with a ratchet brace. It probably cost its weight in gold in labor.

I hope the device as illustrated will stimulate some small tool firm to turn out something similar in design. The bar could be round, a lug being left on the two brackets forming a head stock to take the grip of the vice, while the portion acting as a drill table can then swivel to any desired position and could be made to lock in any ordinary manner.

In use it is, of course, necessary to abandon the superstition that drilling must necessarily be done in a vertical position. A short experience of its capabilities will certainly find it some steadfast friends.

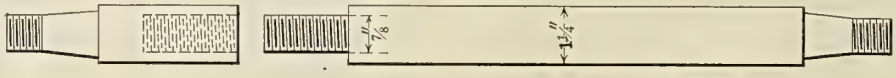
London. A. L. HAAS.

How a Broken Feed Pump Rod Was Repaired

The writer, while first assistant engineer of a ship running between New York and Mexican ports, repaired a broken feed pump rod in the manner shown by the accompanying illustration.

This ship had six boilers and two duplex feed pumps. One was large enough to supply all six boilers while the engines were running full speed; the other was only of sufficient capacity to supply four boilers, and was used while running between Mexican ports when the ship was under reduced speed.

The first day out of New York one of the rods in the main feed pump broke at about one-third of its length from the end —a part that passed through the stuffing box. It seemed almost compulsory that this pump be repaired, for the reason that it was the only pump that could be used to feed the boilers and keep the engines at full speed. The donkey pump was large enough and was connected to the feed line, but it was located on the middle grating, which necessitated lifting the water about ten feet. Part of the auxiliary exhaust steam was led into the filter box to heat the feed water, and with



METHOD OF JOINING A BROKEN PUMP ROD

the feed water at a temperature of 180 degrees Fahrenheit this pump would not lift it that distance, and unless it was so heated the steam pressure could not be maintained. The other feed pump, of course, could not be used unless the engines were slowed.

Fortunately, the break was almost square across, and it was proposed that a stud be inserted in one end and the other end be drilled and tapped and thus fasten the two parts together.

The chief was some doubtful about being able to do this successfully, but, as the pump was useless, agreed to the proposition. The broken ends were first filed perfectly square across and then a hole for a ⅞-inch tap was drilled fairly in the center of each broken end of the rod, which was 1¼ inches in diameter. It required neat work to get the holes in the exact center, they having to be drilled by hand with a ratchet, and of course had to be perfectly parallel with the center line of the rod. When these holes were drilled and tapped in each part of the rod a thread was cut on a piece of ⅞-inch steel, so that it would screw into the holes neatly but not so tightly that it would swell the rod, which was made of Muntz metal. The stud was inserted in one end of the rod and sawed off the proper length, the rod then being in the shape shown in the sketch.

When the two parts were screwed together the ends came together so fairly that the joint just showed like a fine crack. The repaired rod was then put in place in the pump and performed its duty perfectly until arrival in Havana.

A new rod was ordered by telegraph to meet the ship in Havana on the return voyage, and the smaller feed pump used between Havana and Mexican ports, two of the boilers being cut out on this part of the voyage. The repaired rod was afterwards carried as a spare one. J. S.

Mending a Crank Shaft in Queer Surroundings

While many of our seafaring men see many queer things during their travels in foreign lands, yet our different experiences are interesting to each other, just for the novelty that many strange sights bring into our remembrance, for we all see a different side and can tell it in a different way. The little breakdown that was the cause of this narrative would

have long ago been forgotten had the surroundings with its repairs not been so novel and humorous.

It was in 1895 and the first time that I had been in China. We were up the Ming River, at Pagado Anchorage, near Foochow, when the three-inch shaft in our circulating pump broke, between the engine and the centrifugal pump, and not having a spare one, nor the facilities for welding it, arrangements were made to take it to a Chinese blacksmith shop three miles from the ship. The writer, with two men to handle the shaft, was put in a boat and landed at the point where we were told to be at six o'clock the next morning, where transportation would be waiting for us.

On our arrival we saw a man there with a wheelbarrow, who seemed very anxious to get the shaft on the barrow, but this was not what I had expected, and so, after waiting for half an hour for some one to come for us, the Chinaman with the barrow went away and shortly returned with a man that could speak a few words of English, and we were made to understand that the wheelbarrow was the means that had been provided for our transportation.

We put the shaft on, and after fifteen minutes more of expostulations, understood that we were to get on the barrow also, which we did, with the shaft and the lightest man on one side, and the two remaining on the other. We started for the blacksmith shop much faster than I had expected.

After traveling about a mile we came to a turn in the path which brought the wind nearly abaft, and which was blowing quite strongly. Here the man halted, as I thought, for a rest, but I soon had my mind changed, for from under the barrow he hauled out a long pole and set it up on the barrow with guys, just as a small mast would have been rigged in a boat. I thought that he was rigging some kind of a sun shade for us, for the sun was quite warm, but he produced another pole attached to a piece of canvas made fast to the halyard, and up went a sail ten feet high and six feet wide, which he trimmed so that it hauled well, and to my amazement off we went on a wheelbarrow, under sail, and with considerably more speed than we had been making. Before we had reached the blacksmith shop I had a great deal more respect for the barrow man that before we had started.

But once at the shop I soon forgot the barrow man, and almost the rest of the world, for a while, for of all the things that that blacksmith shop contained, and the things that the blacksmith did, kept me so busy that I had time for nothing else. It was very little trouble to show them what I wanted done, for they could see that the shaft was in two pieces and had been broken, and by instinct, I guess, they knew that it ought to be one piece instead of two. However, I must say to their credit that they made a splendid job of it, although I made four more trips on the wheel barrow before I found it finished.

The first thing that I noticed on my arrival, after making sure that they understood the distances, etc., which I made clear with center punch marks and trams, was the way that they shoe horses, which they were doing at the time. A horse to be shod is taken out in the yard, where four strong posts stand firmly set in the ground with a windlass attached to two; a large piece of leather suspended from the other two posts completes the equipment by which the horse is drawn up until clear of the ground, similar to the way oxen are triced up when shod. The foot that is to have the shoe nailed on is fastened in a clamp for that purpose, so that the horse can't move it. Then the shoe, consisting of a very narrow strip of iron, is fastened with hand wrought nails which the blacksmith makes at odd times. All four shoes would not make one of the shoes used on an American horse. It costs about 8 cents (4d.) to put all four shoes on, and less if old ones are refitted.

The forge is roughly made, but similar to any forge except for the attachments that go with it. The fire has a covering of sheet iron, with an opening through which to thrust the iron that is to be heated. In the top of the casing is fitted a large copper kettle, and families send their rice to the blacksmith to be boiled in this kettle for a share of the rice or one quarter of a cent (⅛d.) per pound. When finished it is put aside until the owner calls for it. As it takes the rice from several families to fill the kettle, which is large enough to hold eighteen or twenty pounds at a boiling, it sometimes causes trouble for the blacksmith to give each patron his exact share. He must judge the quantity brought to him by each one, and when it is cooked divide the rice in the same proportion, after setting aside his share. He seemed to have less trouble boiling the rice than he did delivering it, for several of the women were dissatified with his division, but often the very smallest amount, even a teaspoonful, seemed to satisfy them. As near as I could understand the system it was cheaper to have the blacksmith boil the rice than it was to buy fuel and boil it themselves.

This is not all that the blacksmith gets from his fire, however. Along the side of the shop was a brick platform, wide enough for a man to lie out straight on, and long enough so that ten or twelve men lying side by side could be accommodated to sleep or rest. The hot gases passing under the platform from the forge keep the sleepers warm, and this the blacksmith charges for by a regular schedule, according to the length of time that the person wishes to sleep. This warm bed is only used in the winter time.

The bill for the shaft, by the way, was $1.45 (6s. ½d.) and for the barrow man 35 cents (1s. 5½d.) Reader.

Towboat Propeller Wheels

The writer, in the course of his professional work, has at various times noticed that the average towboat engines turn up at revolutions that are in excess of what they should turn for the work they were doing. Having been called upon to improve conditions on several ocean-going as well as harbor tugs, the opportunity was secured to study conditions as they obtain in nearly every case.

The towboat suffers from the fact that it is fitted with the traditional towboat wheel, having excessive area, wide tips and very thick blade sections. Just why a towboat should have a different form of blade from any other type of screw-propelled vessel is beyond my comprehension, and I can say without fear of successful contradiction that there does not exist any reason.

Some of the towboats I have investigated had wheels with radial increasing pitch, some had both radial and axial increasing pitch, while others had axial increasing pitch only. Each maker has had his own idea about expanding pitches, but all seem to have agreed to maintain the wide tip and excessive area, while the thickness of blade, if ever computed, had an allowance of plus 100 percent to cover errors, etc. Let us examine the wide tip, or, better, the traditional type of blade.

From careful examination of numerous wheels of this type we find that there is excessive friction at the tip, and in many cases which the writer has examined the blades were smooth from 12 to 18 inches from the tip, while the remainder of the blade was the same as the day it was put on. That is to say, in many cases the paint was intact, and those which were not painted were the same as received from the foundry. The question may be asked, why is this not due to unequal pitch, etc., or due to casting? It did not happen in one case only, but was manifest in nearly all, and the line of demarcation was very clearly defined.

Now the harbor towboat works under the following conditions at different times: Running free, towing and berthing ships by either pulling or pushing.

A towboat should not be sluggish. As they have large power to enable them to tow, they are as a rule lively. Towing should be done at maximum efficiency. When berthing ships a towboat should recover very quickly. The ordinary towboat wheel is a notoriously poor backing wheel, and unless the man in the pilot house thoroughly understands his wheel there is often a damage suit involving thousands of dollars.

In 1907 and 1908 the writer, in designing several towboat wheels for ocean-going and harbor tubs, decided to depart from all conventional forms of blades, and therefore designed an oval blade having well-rounded tips, and the blade sections such that the factor of safety was 5.5 for cast steel. These propeller wheels were four-bladed, and ranged from 5 feet 6 inches to 8 feet diameter. The projected area ratio was 0.52; the pitch ratio varied from 1.1 to 1.58. The results obtained surpassed expectation, and were as follows:

With the new wheels the revolutions of the engines were decreased; in one instance from 125 to 118, with a much higher efficiency when towing, resulting in a reduced fuel consumption. The boats handled larger tows at a higher speed. The backing qualities were far superior, and when docking handled more readily, thus saving considerable time. One boat which towed car floats, and had to tow from terminal to terminal in a given time, was enabled to handle heavier floats, and reduced her running time twelve minutes on a test against a heavy northeast wind and strong tide. With the old wheel the cut-off was 8 inches, while with the new wheel she could do better work on a 6-inch cut-off.

With the wheels designed for the ocean-going tug the pitch ratio was 1.1, with a projected area ratio of 0.513, and the blade was the same shape as mentioned for the previous tug; in fact, this shape has been used as the parent lines, and I have used it for freight and passenger steamers as well. The pitch in all cases was uniform. It must be borne in mind that a towboat when towing has a very high slip, and combined with this high slip the efficiency with the traditional type wheel is very low, but with the new wheels the efficiency was between 60 and 65 percent, the lower figure for the harbor boat.

Let us return to the cause of the high revolutions. Froude found in recent experiments that wide-tipped blades were about 3 percent less efficient than well-rounded blades. I have found that the wide-tipped blades are in actual practice much greater than 3 percent less efficient, but when compared to an oval blade with well-rounded tip the difference is much greater. I shall in the near future determine this with accuracy from an actual test of a large ocean tug. It is well known that thick blades set up a negative thrust, and this detracts from the positive thrust, enabling the engines to run faster. This condition exists with all the traditional tow-boat wheels.

Any one who has been shipmate with a cast iron or cast steel wheel (the cast steel wheel being cast from the same pattern as the cast iron wheel), which has been replaced by a bronze wheel having the same diameter and pitch as the others, but whose blades are much thinner, has noticed that the bronze wheel has reduced the revolutions of the engines. I have had them reduced ten turns per minute, yet the speed has been higher. The reason for this is simply due to the fact that, the bronze blade being thinner eliminates a great amount of the negative thrust, delivering a greater positive thrust, resulting in reduced revolutions with increased efficiency.

My investigations have led me to believe, and results have amply proved, that the oval blade with well-rounded tips is a far more efficient towing wheel than the wide tip. The blade should not be too wide. The area should not be excessive, a projected area ratio of from 0.5 to 0.55 is desirable, as with increase of area ratio a loss of efficiency will obtain, which has been proved in several cases. With reduced revolutions more work is obtained and higher efficiency, resulting in a saving of fuel, which in one case amounted to 7 tons per month. The boats handled more quickly and recovered in much less time and corresponding distance. The vibrations in three cases, which were with the old wheel very great, entirely disappeared, yet the wheel received no greater care in this detail than the old wheel, and the solution is apparent.

Curves for four boats were plotted as follows:

Abscissæ	Ordinates
Speed in knots	Horsepower.
Speed in knots	Indicated thrust.
Revolutions per minute	Speed in knots.
Revolutions per minute	Indicated horsepower.

All four series of curves show the same characteristics. The friction of engine shafting, etc., was computed at 8 percent, making mechanical efficiency 92 percent, as the engines were well worked down and in good condition. In every case the wheel had no fall back, as there was ample distance from stern post to blade, so that the wheel was not working near dead water, the stern post being thin and the boats having a fine run. Where a stern post is very thick, as on some wooden ships, it may be and is advantageous to give the wheel a fall back for the reasons above, but when this can be avoided it should be, as there is no gain by so doing.

This recalls an incident where a thick stern post was the cause of negative slip appearing on the log until we got tired of figuring that, after the ship tied up, the engines would have to run for a long time to change the negative sign to a plus one. The steamship *E*———, engaged in coastwise trade, being built of wood, had a very thick stern post, which spelled dead water some distance aft of same. The chief engineer decided to fit triangular pieces to it to reduce this dead water. The propeller wheel had no fall back, which in this case was a great error. After these pieces were fitted the slip did change signs, and instead of having negative slip we had an 8 percent, apparent. One night going over Charleston bar this piece was ripped off, although we did not know it at the time we hit, and on the return run we had the negative condition, and when we tied up at the home port an examination revealed the fact that our pieces were not there, but they were at once replaced.

Now a great mistake is made when we do not design the wheel to suit she lines of the hull. With our present-day methods there is no reason to use rough-and-ready methods of design. If it be a towboat, freight steamer or a fast passenger steamer, we can determine the proper power by having our model towed in the tank, and from this information design our wheels to suit our hull and power. A towboat should be an efficient machine when towing, for they seldom run light, and maximum efficiency should be obtained in any case when the ship is performing that service for which she was designed. The question of fuel to-day is a most important one, and every refinement which can be introduced to save it should be adopted.

The average towboat wheel is gotten out in the following manner: An order is received for a wheel of such and such diameter and pitch. At once there is a perusing of the list to see if there is a pattern of one on hand. In case there is not, then the nearest pattern is selected and pieces put on to bring the diameter up to that required; but more than once I have heard the remark. "They won't know the pitch, so let it go"; and go it does. In one place where they do a large wheel business the particulars of a wheel are absolutely unknown; the area is great, the tip wide, and the wheel is of the traditional towboat type.

Charles S. Linch.

New York.

French Line's Activities.—At the annual meeting of the Compagnie Generalé Transatlantique at Paris on June 23, it was shown that receipts in 1912 were $18,294,000 (£3,750,000), an increase of $1,293,609 (£265,500) over 1911. The dividend declared was $401,440 (£68,300), while the company's assets are $38,000,000 (£7,800,000).

Marine Articles in the Engineering Press

The Canadian Lake and Canal Steamer Glenmavis.—The *Glenmavis* is the first vessel to be completed by the newly-constituted North of Ireland Shipbuilding Company, at Londonderry, and belongs to what is known as the canal type of lake freighter, in which the dimensions and the draft are limited by the size of the canal locks through which such vessels ply. The vessel differs from other lake vessels in that she is the first of this type to be constructed on the arch principle devised by Mr. Maxwell Ballard. The hull is 250 feet long between perpendiculars, 42 feet 6 inches extreme breadth, 20 feet total depth, 14 feet load draft. There are six large cargo hatches, and, although it is unusual to install cargo gear on board such vessels, it is understood that the owners contemplate adding four winches, with the corresponding cargo gear, masts and derricks when the vessel reaches the Lakes. Propulsion is by a single screw, driven by a triple-expansion reciprocating engine, with cylinders 16, 26 and 44 inches diameter by 30 inches stroke. Steam is supplied at 180 pounds pressure by two single-ended cylindrical boilers, working under natural draft. The propelling machinery was constructed by Messrs. Richardsons, Westgarth & Company, Ltd., of Middlesbrough. 6 illustrations. 850 words.—*The Shipbuilder,* July.

Shipbuilding at Londonderry.—A new shipyard, the North of Ireland Shipbuilding Company, Ltd., has been installed at Londonderry, a place where shipbuilding has been carried on to a small extent in times gone by, but which during dull times was forced to give up activities in this direction. On the site of the new shipyard there was formerly a well-equipped shipbuilding plant where principally sailing vessels were built. The old yard, however, has been idle for twelve years, and whatever buildings or machinery was left from the old yard were of little use in the new establishment. Practically everything in the shape of buildings, machinery, etc., had to be renewed for the new yard, and, in spite of the fact that so much work was necessary, the firm placed the shipyard in working condition and built and delivered a 250-foot vessel of special type and unusual form within a brief period of six months for actual building, the launch taking place in less than ten months from the date when the company took possession of the site. There are four building berths in the yard, the longest being capable of taking a ship up to 470 feet in length. Electric power is used throughout the entire plant and electric winches are installed alongside the berths. Immediately above the building yard is a drydock, and on the quay adjoining, all forming a part of the shipyard premises, is a large steam crane of 60 tons capacity for fitting out vessels. 12 illustrations. 1,500 words.—*The Shipbuilder,* July.

The Isle of Man Geared-Turbine Steamer King Orry.—The geared-turbine steamer *King Orry* was designed and built for the Isle of Man Steam Packet Company at the Birkenhead works of Messrs. Cammell, Laird & Company, Ltd. This is the first geared-turbine steamer trading in the Irish Sea. After a brief historical review of the work turned out at the Birkenhead works, a detailed description is given of both the hull and machinery of the new vessel. She is 300 feet long, 43 feet beam, 12 feet 6 inches draft, 2,550 tons displacement, 1,850 tons gross, driven by twin-screw geared turbines, indicating 8,000 horsepower, using steam at 170 pounds pressure, developing on trial a speed of 20.75 knots. The hull is subdivided by nine watertight bulkheads extending to the upper deck. Accommodations are provided for 1,600 passengers and a crew of seventy-five. The propelling machinery includes two high-pressure and two low-pressure turbines of the latest Parsons compound impulse and reaction type. The two high-pressure turbines are in the center, and the two low-pressure turbines, with which the astern turbines are incorporated, are in the wings. The conditions of service demand ample backing power, and therefore the astern turbines are designed to develop 60 percent of the maximum ahead power. Steam is supplied by three Scotch boilers, two double-ended and one single-ended, with a total collective heating surface of 14,385 square feet and a total grate area of 383 square feet. 19 illustrations. 2,250 words.—*Engineering,* June 27.

The New French Battleships.—Some novel features of more than usual interest will be found in the four French battleships that are to be laid down this year. They are to be 574 feet long, 89 feet beam, 25,000 tons displacement on a draft of 28 feet 3 inches. The main armament will consist of twelve 13.4-inch guns, carried in three quadruple turrets placed on the center line. The secondary armament consists of twenty-four 5.5-inch guns. The designed speed is 21 knots with about 32,000 horsepower, which will be developed on four shafts, the two outer shafts being driven by reciprocating engines and the inner shafts by turbines which are self-contained and entirely independent of the reciprocating engines. The main armor belt will be 12½ inches thick, and above that the armor will be reduced to 8 inches. The most striking features of this design are, of course, the use of quadruple turrets, which are severely criticised; the installation of two different types of main engines independent of each other, in spite of the proved economy of the combination of the two; the adoption of a special type of Belleville watertube boiler, specially arranged to admit forcing at high rates of combustion, and the location of the secondary battery, which does not seem to be advantageously arranged. Other novel features referred to are the use of two rudders in place of one, which is an innovation in French warships, the installation of anti-rolling tanks, and the installation of special pumping apparatus provided for use in the event of submarine damage. 2,300 words.—*The Engineer,* July 4.

The New Gladstone Dock at Liverpool.—A few paragraphs at the beginning of this article outline, briefly, the remarkable increase in volume of traffic and the steady growth in the size of individual ships which have demanded great improvements in the facilities and accommodations of the port of Liverpool. The main question discussed in the article is that of dock expansion and reconstruction. A very comprehensive outline of the work done in this respect during the last quarter of the nineteenth century is given, showing the necessity for the provision of a graving dock of the size of the new Gladstone dock, which is 1,020 feet long, 120 feet wide at the entrance, with a depth of water over the sill of 46 feet at high water of ordinary spring tides. The Gladstone dock forms the first part of an extensive scheme involving the expenditure of over three million sterling, authorized by the act of 1906. The scheme embraces dock works extending northwards on the Seaforth shore from the extreme northern end of the existing docks for approximately 2,600 feet and seawards into the River Mersey for about 2,200 feet. The works proposed include besides the Gladstone dock an entrance lock from the river, which finally will undoubtedly exceed the dimensions originally proposed of 870 feet length and 130 feet width. In the dock area there is to be a half-tide dock of 14¾ acres, and from this area there will stretch landwards two branch docks each 400 feet wide and separated by a quay over 1,300 feet long. There will be double story sheds 100 feet wide adjacent to each wharf face. The main part of the article is concerned, of course, with details of the design, construction and operation of the Gladstone dock. An interesting feature of the pumping plant is the fact that the pumps will be driven by oil

engines of the two-cycle Diesel-Carels type. The complete pumping installation is carried out by the Worthington Pump Company, Ltd. The duty required is to empty the dock of its full contents, about 44,000,000 gallons, or 200,000 tons, on an 18-foot tide, in two and one-half hours. There are five sets of centrifugal pumps with discharge pipes 54 inches in diameter, each having a valve operated by a hydraulic cylinder working under 700 pounds pressure. Each pump is driven direct at 180 revolutions per minute by a four-cylinder engine of 1,000 brake horsepower. 18 illustrations. 5,500 words.—*Engineering,* July 4.

The Cruising Element in Warship Machinery.—Two destroyers are being built by Messrs. Yarrow which are similar to three very successful vessels built by the same company for the British navy, which have a length of 255 feet and a displacement of 765 tons, and with which a speed of over 35 knots was realized. On the two destroyers now building oil engines are being installed for cruising, and it is estimated that this arrangement will give a radius of action of 700 sea miles at full speed and of 8,000 sea miles at half speed. The disadvantages of the arrangement, however, appear to be the reduction of the maximum speed obtainable to the extent of about one and one-half miles per hour, the addition of about 100 tons to the weight of the machinery, and an increase in the space occupied by the machinery of about 15 percent. Another serious objection to this arrangement is the fact that when cruising with the oil engines the power for high speed at short notice which should be available in a warship could not be obtained without keeping up steam in the boilers and keeping the turbines heated. On the other hand, in a typical present-day destroyer fitted with the normal type of turbine machinery without a cruising turbine the vessel might carry 200 tons of oil fuel, which, at a given cruising speed, would enable her to have a radius of action equal to 2,000 nautical miles. The maximum speed with the tanks full would be 32 knots, but, as the fuel was gradually consumed, the speed would run up to 35 knots, at which speed the vessel could steam for twenty hours. By adding an internal-combustion engine to achieve economy at cruising speed the radius of action at cruising speed would be increased to 8,000 nautical miles, but on account of the increased weight of the machinery the maximum speed would be reduced 1½ knots. In this case the time during which full speed could be maintained would still be twenty hours. A third case would involve the installation of cruising turbines in addition to the main propelling turbines. The weight would be considerably less than in the case of the fuel oil engine, and for the same displacement more fuel could be carried; thus the radius of action would be a little more than half that of the destroyer with internal-combustion engines for cruising, or about 4,500 nautical miles. The speed with the tanks full would be the same, but with the tanks empty would be higher, and full speed could be maintained for twenty-eight hours instead of twenty. If superheating to the extent of 100 degrees were adopted for the cruising turbines, the radius of action might be increased to 5,000 nautical miles. The conclusion is reached that on the whole the advantages were distinctly in favor of adopting the cruising turbine and of using superheated steam. Because, although there is some loss in the radius of action at cruising speed, there is a gain in the rate of speed during a prolonged full speed run as well as the possibility of covering nearly 50 percent more ground at full speed. 1,600 words.—*Engineering,* June 20.

Steam Turbines.—By Lieut. B. A. Straight. This article is a continuation of a paper which appeared in the preceding volume of the United States Naval Institute Proceedings. It is entirely descriptive, and takes up the Curtis, Parsons and Terry turbines, illustrating the description by drawings of turbines actually installed in certain United States war vessels. A chart is given showing the performance obtained with different methods of turbine drive, including direct Parsons and Curtis installations and geared turbines and turbo-electric drive. 5 illustrations. 2,300 words.—*United States Naval Institute Proceedings,* June.

The Desirability of Using High Mean Referred Pressures.—By E. M. Bragg. In the past it has been considered that an economical engine must have a large number of expansions. The author considers that too much importance has been assigned to the question of the number of expansions. Experimental results have shown that more attention should be given to the mean referred pressure employed, and to the cut-offs in the intermediate and low-pressure cylinders if economy of steam is desired. The author refers to statements made by Mr. R. Royds in a paper read before the Institute of Engineers and Shipbuilders, and a paper by Professor Weighton upon "Receiver Drop in Multiple Expansion Engines," read before the North-East Coast Institute of Engineers and Shipbuilders, which tend to bear out his statement. The results obtained from the trials of the U. S. S. *Delaware, Birmingham,* and upon H. M. S. *Argonaut,* agree in general with the conclusions reached by Mr. Royds and Professor Weighton, to the effect that higher mean referred pressures are necessary for economy. In every case the use of lower mean referred pressures is accompanied by increased steam consumption. In considering the effect upon the steam consumption of the percentage of cut-off used in the low-pressure cylinder, it is shown that an appreciable reduction in steam consumption can be obtained with an earlier cut-off in the low-pressure cylinder. 2 illustrations. 2,400 words.—*Journal of the American Society of Naval Engineers,* February.

The Lillie Quadruple Evaporator U. S. S. Dixie.—The Lillie quadruple-effect sea water distilling plant, designed and patented by S. Morris Lillie, of Philadelphia, Pa., and installed on the U. S. S. *Dixie* by the Sugar Apparatus Manufacturing Company, of Philadelphia, is peculiar to such a degree in its mode of operation and in other respects as to make it radically different from anything that has been used heretofore for the purpose in the navy. There are two very salient differences: First, the evaporation from the sea water is from films caused by a mechanical showering of the sea water over the evaporating tubes, and, second, the movement of the evaporators or heat through the apparatus is periodically reversed. The former greatly promotes the efficiency of the evaporating surface, and the latter by a frequent changing of the temperatures through the effects prevents incrustations to such a degree that the apparatus may be run for long periods without a material falling off in capacity. The rated capacity of the quadruple effect is 25,000 gallons of distilled water per twenty-four hours. The space occupied by the apparatus is about one-half of that occupied by the navy type of the same rated capacity, and the weight is about 30 percent less. The apparatus is thoroughly described with the aid of numerous diagrams, and the results from a 72-hour capacity test are given. A careful account was kept of the actual consumption each day, from which it was estimated that nearly 74 pounds of fresh water were made per pound of coal used, a remarkable result, which is due to the use of exhaust steam as the heating agent. The plant is more complicated and requires more careful attention than the navy type, the liability to breakdown is slightly greater and it is more difficult to repair, but this should be considered with the fact that it has more functions than the navy type. 5 illustrations. 5,500 words.—*Journal of the American Society of Naval Engineers,* February.

New Grace Liner.—The steamship *Santa Catalina,* building at Cramp's shipyard for W. R. Grace & Company, of New York, was launched July 19. Her dimensions are: Length, 420 feet; beam, 54 feet; capacity, 10,000 tons. She will be used in the Panama Canal trade.

New Books for the Marine Engineer's Library

Works Management

The Protection of Trade Designs By Robert M. Neilson. Size, 4¾ by 7¼ inches. Pages, 29. Glasgow, Scotland: Fraser, Asher & Company. Price, 6d. net.

The purpose of this volume is to supply information as to the registration of design and the protection afforded thereby. Also to indicate as far as possible what is and what is not suitable subject matter for registration, and generally to give advice on the subject of a nature to be readily understood and appreciated by manufacturers, merchants, agents and the like. The frequent neglect of many manufacturing firms to take the precaution of registering trade designs results in needless losses. As this is apparently due to ignorance on the part of the manufacturers as to the advantages which can be gained by registration, it would be worth while for every manufacturer to obtain a copy of this pamphlet, especially those manufacturers who do business in Great Britain, the country to which the contents of this pamphlet applies.

Cost Reports for Executives. By Benjamin A. Franklin. Size, 5½ by 8½ inches. Pages, 149. Ten charts. New York, 1913: The Engineering Magazine Company. Price, $5.00.

As stated in the preface, the object of this book is to discuss with the executive of a manufacturing plant, after a considerable experience, not how to build a cost system, but what he should have when his cost system is built; to illustrate it by actual forms, filled with figures to make their use clear and to discuss with him the values, the uses and the essential necessities of a right and practical cost system, with the idea in mind constantly of showing him, through casting it into the forms shown, the vital operations of his material, labor and expense. Their relations, one to the other, are made plain, and the whole manufacturing situation so illustrated as to offer him a grip upon it. The discussion in the book, therefore, is not limited in application to any particular business, but illustrates principles that can be carried out in various ways to suit varying conditions. A great deal has been written upon the subject of costs, but this book takes up the matter from a somewhat unusual point of view, although a most valuable point of view, and one that should make the subject of particular interest and value to manufacturers in any field of business.

Modern Organization. By Charles Delano Hine. Size, 5 by 7¼ inches. Pages, 110. New York, 1912: The Engineering Magazine Company. Price, $2.00.

This book forms an additional volume to the "Works Management Library," published by the Engineering Magazine Company, and is made up of a series of articles which appeared originally in *The Engineering Magazine* early in 1912. Major Hine's "Unit System," which has met with remarkable success on the Harriman Lines in promoting efficiency without causing trouble, is based on the fundamental ideas of correcting over-centralization and over-specialization by simple changes of official relation and departmental routine. The book explains exactly what this system is and how it was put into effect on the Harriman Lines. A striking feature of the system, and one which will appeal to works managers, is the fact that no elaborate system is introduced. There is no cumbersome mechanism, no changes are made affecting the rank and file, the system works by changing the relations and the viewpoint of the directing official, thus operating first upon and then through him. While the ideas and methods have been applied most widely to railway operation, they may be adapted to any situation, whether Government bureau, commercial company or manufacturing and industrial corporation, as the policies are largely mental suggestion, which creates and transforms the ideals which are the first principle of efficiency. The scope of the volume is indicated roughly by the chapter headings, which are as follows: The Unit System on the Harriman Lines; Operation of the Unit System; Broadening the Ideals of Line Supervision; Over-Specialization; Fallacies of Accounting; Supplies and Purchases; Line and Staff; Genesis and Revelation of Organization.

American Yachts

Lloyd's Register of American Yachts, 1913. Size, 9 by 7 inches. Pages, 506. Illustrations, 46 full-size plates. New York, 1913: Lloyd's Register of Shipping, 17 Battery Place. Price, blue cloth, $8.50; plain canvas, $7.

Coincident with the opening of the yachting season, the eleventh annual edition of Lloyd's Register of American Yachts is now ready and has been shipped to subscribers. The book contains the particulars of 3,557 power and sailing yachts distributed in all parts of the United States and Canada, and also Mexico and the West Indies, located as far north as Nova Scotia and British Columbia, and as far south as Mexico, Bermuda and Cuba. The yacht clubs of this same territory, to the number of 526, with 36 yachting associations, are also included, with the full list of officers for the current year. The yacht owners number 3,550, the address of each being given.

The new yachts of the year, to the number of a little over 300, are made up mainly of cruising launches of 30 to 50 feet length, the majority of the raised-deck and trunk cabin type. There are also a number of cruising yachts of about 100 feet, driven by gasoline (petrol) engines, representing the latest progress in this most useful type. The steam division has been increased by several large cruising yachts and a few of medium size.

The most interesting development of the year in building is the new one-design class of 50-footers, wooden yachts, 72 feet over all, 50 feet load waterline, 14 feet 6 inches breadth, and 9 feet 9 inches draft, rigged as knockabout sloops, no bowsprit, single headsail, and pole mast carrying a large club topsail. This class of eight yachts promises a revival of yacht sailing about New York and Newport, and should do much to awaken a wider interest in racing. Another interesting class includes five one-design schooners of 40 feet load waterline, fostered by the Stamford Yacht Club, that will be seen in all races on Long Island Sound. A still smaller class of four one-design auxiliary yawls of 32 feet load waterline has been built for the south side of Long Island.

The largest of the sailing yachts is the new *Vagrant* built for Mr. Harold Vanderbilt, a composite schooner of 78 feet load waterline, to be raced abroad; while Mr. Max Agassiz has replaced the old *Kirin* by a steel auxiliary schooner, with an engine of the Diesel type, 82 feet load waterline, for cruising. A goodly number of sailing yachts has been added in the smaller classes, and the season promises to be a specially lively one as far as sailing and power races are concerned.

This year's Register contains a total of 506 pages, including The American Yachting Trade Directory, which has become a very valuable feature; the 46 color plates show the burgees of 548 yacht clubs and associations and the private signals of 1,822 yacht owners, together with national ensigns, weather signals and the International Code flags. It is issued in the two standard bindings—blue cloth with gilt edges and with the owner's name on the cover, and the plain yacht canvas.

ENGINEERING SPECIALTIES

Welin Davits on the Imperator

No marine lifeboat installation offers so many points of interest as that on the new Hamburg-American liner *Imperator*, made by the Welin Davit & Engineering Company, London. A feature which at once appears as a most striking innovation is the removal of a large number of the lifeboats from the top deck to the lower promenade deck, which is 20 feet below the boat deck. Besides the advantages affecting the stability of the ship by placing so many lifeboats on a lower deck, various other valuable points are gained, both from the lifesaving point of view and in other ways. Not only will the boats on the lower deck have a better chance of reaching the water safely, and the lowering operation occupy less time, but the risk of overcrowding the decks in time of danger will be greatly minimized. Furthermore, the space gained on the upper deck by placing the boats on a lower deck will be fully appreciated by the passengers. The principal mechanical feature of the arrangement is that one of the two davits is supported above the boat instead of socketing it at a point below, as is usual. The two davits are connected by a coupling rod attached to short cranks on the davits proper, so that the arms stand at every point parallel to one another, the boat travels parallel with its own axis and the tackles always remain in a vertical position.

Another special feature of the installation on the *Imperator* is the manner of controlling the lowering of the boats and the means for hoisting the boats on board again by electric power. Along the inboard side of the deck on which the boats are stowed runs a continuous shaft operated by an electric motor, and opposite each set of davits is a mechanical device operated by a single bar. As can be seen from Fig. 1, there are only two positions in which the bar can be moved—either forward or back. With the bar in one position the boat is lowered and in the other position the boat is hoisted. The apparatus works either for driving or lowering entirely by friction. The brake arrangement is so sensitive that the lowering speed cannot exceed 12 feet per second, and the brake handle, if accidentally dropped by the operator, automatically closes the brake, thus gradually checking the descent of the boat. The electric motors are used only for hoisting.

In order to keep the boat on an even keel while lowering, or to keep the boat level with the deck of the ship, a balanced fall adjuster is provided, which can be seen on one of the davit frames in Fig. 2. The standing part of each tackle is led over sheaves to the adjuster drum, and from 12 to 20 feet wound thereon in opposite directions. The drum is actuated by a self-locking worm, and when revolved pays out one fall and hauls in the other, approximately in equal lengths. In this way the falls are always under tension and all possibility of kinking is prevented.

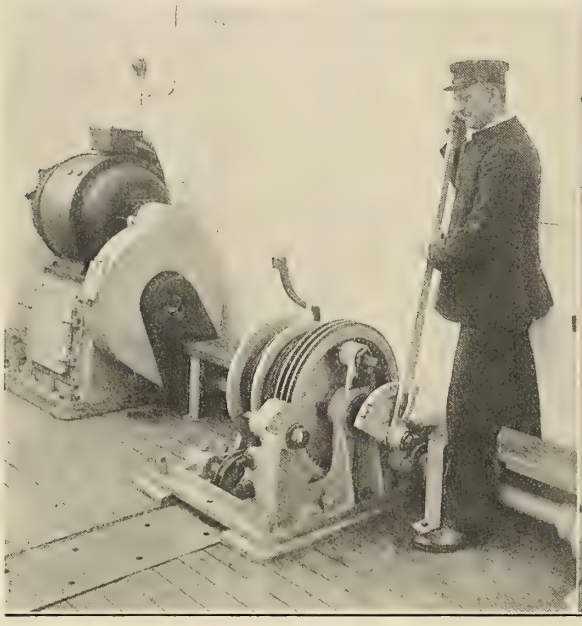
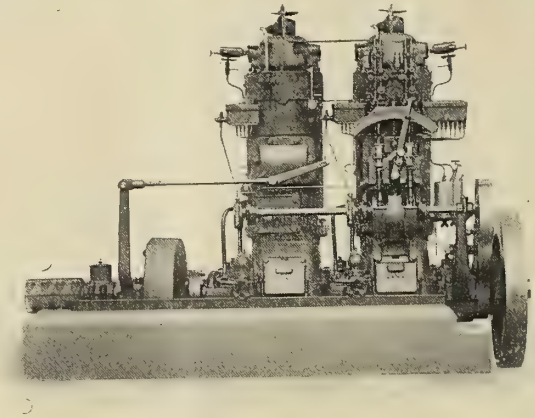


FIG. 1.—HOISTING AND LOWERING CONTROL

FIG. 2.—BALANCED FALL ADJUSTER ON DAVIT FRAME

The "Avance" Crude Oil Engine

The "Avance" crude oil engine, illustrated on this page, which is manufactured in Sweden, is placed on the market in England by Bovine & Company, Ltd., London, E. C. This engine is said to have been the first two-cycle engine to successfully use crude oil as fuel. The engine is guaranteed as suitable for running with any heavy oil which is lighter than water. It consumes oil as cheap as from 2¾ to 3d. per gallon, the fuel consumption being .57 pint per brake-horsepower-hour in ordinary commercial use, while an even lower fuel consumption has been reached on tests. It is also claimed that the consumption of lubricating oil is more economical than with the ordinary types of semi-Diesel and Diesel engines. At the Avance factory the manufacture of the engine was brought to a high standard of excellence, not only by the careful design and choice of materials, but also by the use of



up-to-date tools and a perfect system of jigs and gages throughout all departments. A most efficient method of direct reversing is employed by which the engine is automatically slowed down before the reverse action takes place. By thus providing effective cushioning the wear and tear which is likely to occur by reversing is avoided. A water-cooled injection valve is fitted to the engine, which safeguards the temper of the injection valve spring, thus doing away with a frequent source of trouble in this direction. The governing of the engine is very close, and is on the hit-or-miss principle, except in special electric lighting sets, where a sensitive centrifugal governor is employed. The engines are built in sizes from 3 to 320 brake horsepower.

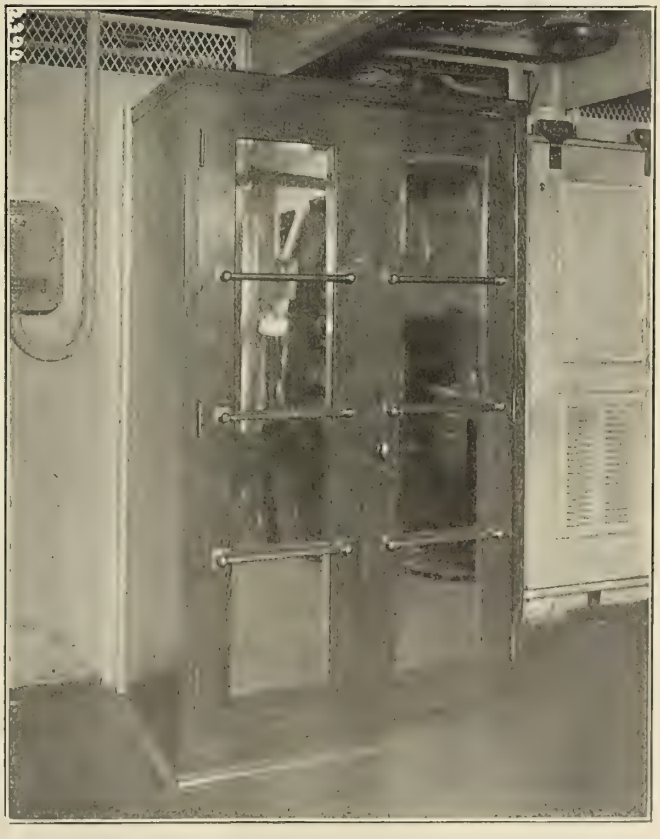
Steel Furniture, Bulkheads, Doors and Trim for Battleships and Merchant Vessels

The first warships to have a complete equipment of steel furniture, doors and trim were laid down at Cramp's shipyard, Philadelphia, in 1898. These cruisers were the *Variag* and *Retvizan,* built for the Russian navy. Both were sunk off Port Arthur in the Russian-Japanese war, and after two years were raised by the Japanese. The steel furniture in both ships was found to be in good condition, and it is understood to be still in use by the Japanese navy. That enameled steel furniture can withstand the corrosive action of sea water under such extreme conditions is a striking illustration of the durability of the product and its suitability for naval construction.

DOUBLE BERTH, METAL DOOR AT RIGHT

BOOK CASE

LAVATORY BOARD



WARDROBE, SLIDING DOOR AT RIGHT

The development of steel furniture and trim for battleship use has been brought about by eminent naval architects, working through such well-known shipbuilders as the United States Navy Department, Cramp's shipyard, Philadelphia, Pa.; New York Shipbuilding Company, Camden, N. J.; Newport News Shipbuilding Company, Newport News, Va.; Fore River Shipbuilding Company, Quincy, Mass., and many others. This class of work has been built and installed by the Art Metal Construction Company, Jamestown, N. Y., and the photographs of typical battleship equipment reproduced on page 365 were obtained through the courtesy of this company.

One of the first considerations that led to the adoption of steel furniture by naval authorities is the complete sanitation afforded. Nearly all United States battleships and other naval vessels during the past fifteen years have had complete metallic equipment installed in the pantry and food storage apartments. Another consideration is the fact that steel furniture is "splinter proof." During the Spanish-American war more men were killed and injured during naval engagements by flying splinters of wood than any other cause. It is, therefore, evident that the elimination of woodwork throughout the entire ship is highly desirable as a factor of safety when vessels are in action. The substitution of steel for all interior woodwork and furniture renders flying splinters a thing of the past.

In merchant vessels equally striking advantages can be obtained by the use of metal furniture, trim and fittings, although in such ships the careful consideration of such matters as weight, cost, durability, strength, etc., is of first importance. In view, however, of the recent developments in steel construction in the manufacture of doors, windows, office partitions, furniture, etc., it is evident that the item of weight can be disposed of. While it is probable that the cost of finished steel is more than wood, yet it is possible, by the use of steel, to eliminate some parts of the structural work. This, together with the reduced cost of insurance against fire, should practically offset the greater cost. That light steel, properly treated, is durable, is attested by the fact that it has been used on battleships for a number of years and is now being used more extensively. The matter of strength is entirely up to the designer, since steel can be bent into such forms as will give the desired results. In fact, it seems wholly within the scope of possibilities to build the "joiner work" of vessels of steel instead of wood, rendering it practically impervious to fire. Added protection against cargo fires in merchant vessels can also be obtained by the installation of suitable fire partitions in the cargo spaces, together with the ordinary efficient fire fighting apparatus required by law.

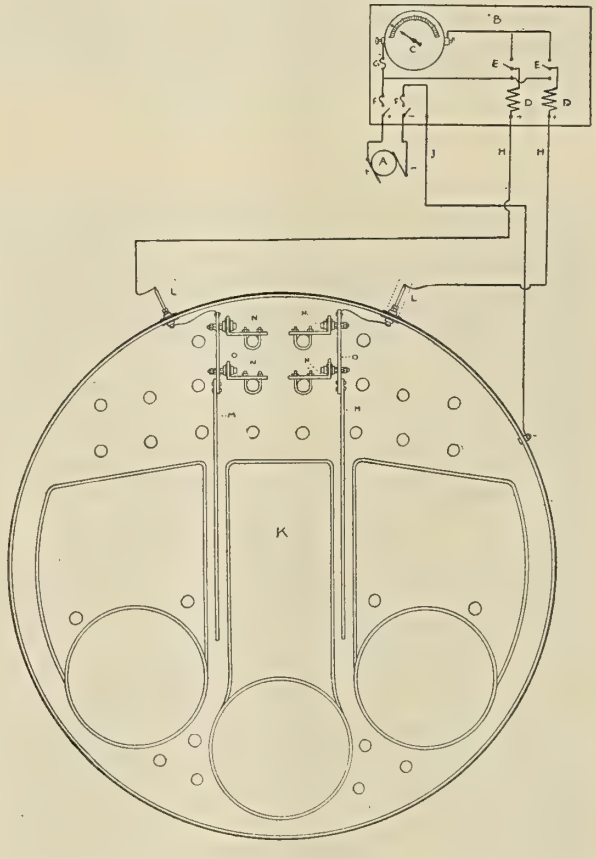
For decorative purposes any architectural effect desired can be obtained with metal in as good form as in any other material. Columns, capitals and all other forms of ornament can be made of the lightest woods, and then completely covered with a coat of copper or bronze of any desired thickness which will insure lasting qualities as well as absolute fire protection. Doors, frames, blinds, berths and all furniture in staterooms, offices, pantries, dining rooms, storerooms, etc., can be made of steel that is of less weight than wood and is also more durable. The cost of steel is not so far in excess of the cost of wood but that its use is permissible. For the simpler construction of stateroom bulkheads, corrugated plate can be used, the corrugations to be of such size and shape that they will afford all the stiffness required. Window and door frames of steel can easily be set in bulkheads of this kind. Sash, blinds and doors are now being made for various purposes, and they can be successfully applied to naval architecture.

For the more ornate staterooms and for dining saloons and lounging saloons, a steel plate construction can be used with moldings and ornament applied. The ornament can be of a very light-weight wood, or any other light-weight material, covered with copper or bronze by the electro-plating process. This process renders the wood absolutely fireproof, and does not add much to the weight. As the material employed in the ornamentation is rich in appearance, by its judicious use the amount of ornamentation to attain the desired result can be greatly reduced. The number of moldings can also be reduced. Stairs can be constructed of bent steel plates, and bronze or aluminum newels and balustrade. By the use of extruded bronze, of light weight but sufficiently strong, hand rails, tread nosings, etc., can be produced. Gallery facias can be made of light bronze steel moldings, and the gallery railings can be made as ornate as desired, and yet not have excessive weight, by the use of wrought steel of light members. In addition to the fire protection it affords, by the use of steel bulkheads the creaking which is always present in wood construction will be materially, and possibly entirely, eliminated.

Although no decrease in fire insurance rates has been published, as yet, by the Board of Underwriters for vessels completely equipped in steel, an understanding exists that vessels of the merchant marine equipped as outlined above will be privileged to receive very substantial reductions in insurance rates. It is even possible that the insurance rates will be cut one half, thus effecting a tremendous saving, not to mention the decreased cost of maintenance and absence of repairs.

The Cumberland Patent Process for the Protection of Metals

The Cumberland patent process for the protection of metals, manufactured by the Cumberland Syndicate, 44 Charing Cross, London, S. W., England, is an electrical process consisting of the use of one or more electrodes installed in a boiler, or other

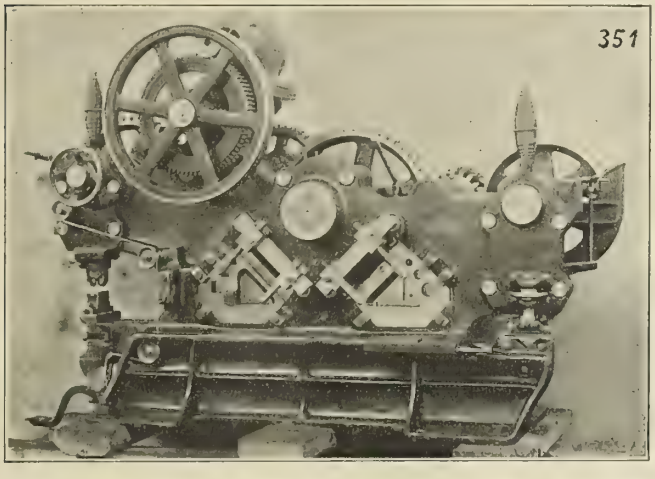


vessel, containing water and connected to the positive terminal of the direct-current supply, the boiler itself being connected to the negative terminal and the water forming the electrolyte. The illustration shows diagrammatically the apparatus which is used in this process and its arrangement in connection with the boiler. *A* is a motor generator; *B*, a switchboard; *C*, an ammeter; *D*, adjustable resistances; *EE*, two-way switches;

FF, double-pole switches and fuses; *HH* are the wires from the positive pole of the apparatus to the insulated poles, *LL*, in the shell of the boiler, which conduct the current to the detachable iron electrodes, *MM*, attached to the steam space stays, *NNN*, while *J* is the wire from the negative pole to the boiler shell. The results from experiments by competent authorities and from actual experience in service, it is claimed, show that this process stops corrosion in boilers or other metal vessels containing water; that it removes scale from the heating surface of a boiler, and also prevents scale from forming; and it is also a safe water alarm; for if an electrode is placed horizontally in a boiler just above the danger zone for low water, and lights are placed in the circuit with the current through them, the lights will go out when the electrode is not immersed in the water, and, consequently, will give a positive indication of low water in the boiler. For the operation of the apparatus only enough voltage is required to overcome the resistance through the water and to overcome any electromotive force due to the difference of potential of the metals comprising the boiler when they exist. Too high voltage, however, gives no harmful results on the boiler, but merely increases the action on the electrode, requiring it to be removed more frequently. It is claimed that the apparatus requires practically no attention after once being properly installed and started.

"Imperator" Quadruple Combination Machine

The Wiener Machinery Company, New York City, American managers for the Oeking Company, Dusseldorf, Germany, have placed on the market a quadruple combination machine under the name of the "Imperator." The design of this machine was brought about by the success achieved with the Oeking solid steel frame triple combination machines which have been on the market for some time past. Many inquiries



were received for a combination machine which could miter right and left angles without any change of knives, and it is also found that a market exists for machines which, besides cutting and mitering angles, rounds and squares, would also cut beams and channels.

The new type of the Oeking solid steel frame quadruple combination machine, styled "Imperator," is therefore built to combine in one frame ready for work all the tools for almost any kind of cutting, shearing, coping, mitering and notching. The fact that the frame is one massive piece of steel permits a compactness which will make it a most suitable and economical tool for crowded shops. It is also particularly suited for plants where driving power is limited.

The machine illustrated is capable, without any change of tools, of splitting plates of unlimited length, or cutting flat bars, shearing off rounds and squares, cutting and mitering angles and tees, both right and left at any degree, and of punching plates and structural material, both webs and flanges. With interchangeable tools, beams and channels or any other shape can be cut. The punching tools can also be interchanged for coping, mitering, etc.

The machines are built in three sizes, and can be furnished with tight and loose pulley for belt drive or can be arranged for direct-motor drive. If it is desired the machines can be equipped on a turntable to facilitate mitering long bars of angle iron. It is claimed that these machines do not cost more than the equivalent equipment in single machines, and that they are, furthermore, very economical in operation, saving both time and labor.

The Martin Patent Davit

The Martin patent davit, manufactured by Sir W. G. Armstrong Whitworth & Company, Ltd., is a davit of simple construction, built of steel angles and plates, combining lightness with strength and operated by direct adaptation of the crane and winch principle. The working parts of the davit are practically the same as those used in an ordinary winch, so that little instruction is needed to operate the davits, and the working parts are inclosed in a watertight compartment, which

thoroughly protects them from damage by the weather. To swing the davit outboard it is simply necessary to turn a crank, while a brake control is provided for lowering the lifeboat. A separate mechanism is provided for hoisting the lifeboat from the water. Wire fall are used, which does away with the constant renewal of the old type manilla falls and prevents the twisting or fouling of the falls after the boat is launched. Where the lifeboats are double banked, or carried across the deck, a skid is provided, consisting of two trackways, on each of which runs a carrier fitted with chocks to hold the lifeboat. These carriers are connected with a shaft, and by turning a crank which actuates a worm gear the shaft is revolved and the boat is run out under the davit. Thus one set of davits is capable of handling several boats. The lifeboats are lowered at both ends in unison, so that the lifeboat reaches the water on an even keel. These davits are sold exclusively by Messrs. Ogilvy, Gillanders & Company, London and Liverpool.

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H. L. ALDRICH.

Sworn to and subscribed before me this 13th day of June, 1913.

(Seal) GEORGE E. MULLER,
Notary Public.

(My commission expires March 30, 1915.)

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,062,181. COLLAPSIBLE LIFE-BOAT. SOPHUS NYBOE, OF BROOKLYN, NEW YORK.

Claim 3.—In a collapsible boat the combination of two non-collapsible sides, means for folding the same together along the keel line, a collapsible bottom and vertical collapsible partitions for separating the space below the said decks and the said bottom from the interior of the boat. Nine claims.

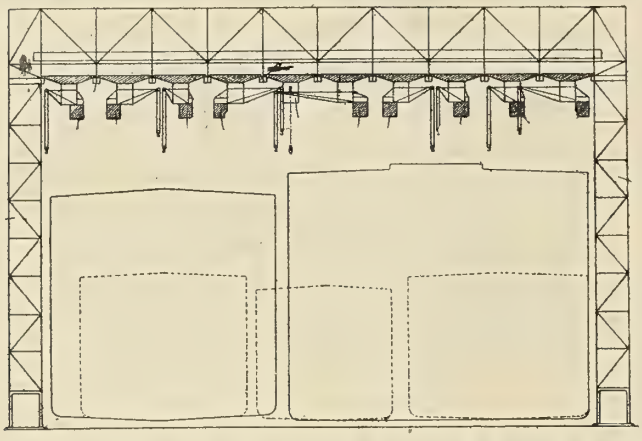
1,061,309. SHIP'S LOG. THOMAS H. McQUOWN, OF CAMBRIDGE, MASS.

Claim 1.—In a ship's log, the combination with a frame of flexible means to tow said frame in close proximity to the hull of a vessel, whereby said frame is free to move laterally in any direction independently of the vessel, an actuator flexibly sustained by the frame and operated by its movement through the water, an indicator situated at a distance from the actuator and means to operate the indicator by the actuator, said frame having means to prevent the actuator from contacting with the vessel. Twenty-three claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

19,781. IMPROVEMENTS IN AND RELATING TO SHIP-BUILDING SLIPS. W. E. EVANS OF LONDON, W. C.

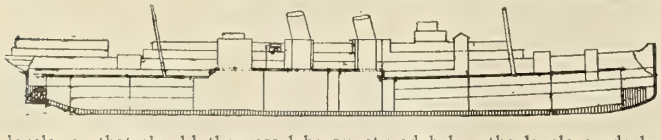
Claim.—Slips for ships, according to this invention, are provided with a number of weight-raising appliances movable along the length of the slip, and a number of rotatable traveling cranes are provided side by



side in such a manner that (considering the area of the slip to be divided into a number of longitudinal strips or "work areas" for each of which a crane is provided) each crane can serve the "work areas" of each of the adjacent cranes either partly or completely so that it is possible wholly to serve the "work area" of any crane in use or disabled by employing the adjacent cranes working together or a single adjacent crane, for the whole length and breadth of the slip.

10,201. IMPROVEMENTS IN THE CONSTRUCTION OF SHIPS. J. MACKINTOSH, OF PAISLEY, SCOTLAND, AND H. MOWATT, OF OXTON, BIRKENHEAD.

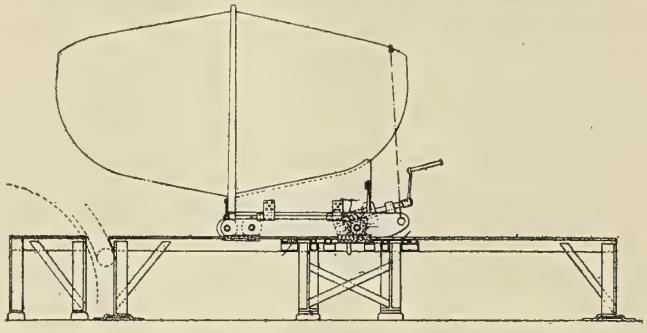
Claim.—The ship is constructed with an air-tight deck or decks, and with means for closing all the deck openings, in horizontal planes, or



levels, so that should the vessel be punctured below the levels or decks and bulkheads, it would be possible, by closing at these levels all the holes communicating with the punctured compartment or compartments, to prevent the escape of the contained air and thus to prevent water from rising indefinitely. Ships thus constructed are also fitted with air pumps connected to the ordinary bilge and ballast services or to one or other of these so that they, while generally in use for the ordinary purposes for which they are installed, may also be used in conjunction with the air pumps or compressors, to supply air to, as well as to draw water from, the compartments to which they are connected. Some of the air-tight compartments may be detached at will and left air-tight. A chemical substance evolving gas in contact with water, with air, or both, may be discharged into the air-tight compartments to form the gas necessary for expelling the water; or gas otherwise generated may be used.

13,777. IMPROVEMENTS IN APPARATUS FOR LAUNCHING AND CHOCKING BOATS. SIR W. G. ARMSTRONG, WHITWORTH & CO., LMTD., AND A. J. LEWKOWICZ, OF NEWCASTLE-UPON-TYNE.

Claim.—This invention relates to improved arrangements on board ship for handling boats which are supported on cradles, moving on ways or tracks. A cradle travels on two athwartship ways, which are hinged



so that they can be turned into positions shown in dots to obstruct the deck as little as possible. The cradle is provided with a pinion actuated by a handle and worm gear and meshing with the racks formed by perforations along the upper surface of the ways so that the boat carried by the cradles can be moved in or out by turning the handles.

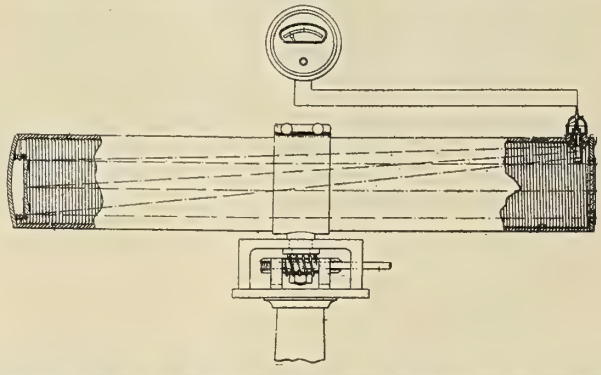
18,239. "IMPROVEMENTS IN THE CONSTRUCTION OF BULKHEADS FOR SHIPS." H. MOWATT OF BIRKENHEAD.

Claim.—To construct bulkheads in ships of greatly increased strength and resistance to collapse, without appreciably diminishing the cargo

capacity of the hold, horizontal girders are attached to the bulkheads and to the sides of the ship at intervals, such girders being wider at the center than at the ends, and vertical girders are attached at intervals to the horizontal girders.

10,576. IMPROVEMENTS IN MEANS FOR DETECTING THE PRESENCE AT A DISTANCE OF ICEBERGS, STEAMSHIPS, AND THE LIKE. A. HILGER, LTD., AND L. BELLINGHAM, BOTH OF 75A CANDEN ROAD, LONDON, N. W.

Claim.—This invention relates to apparatus for detecting the presence at a distance of ice bergs, etc., and consists primarily in the use of a radiation receiver sensitive to long infra-red wave lengths, such as thermopile or bolometer, the receiver being directed towards the region



which it is desired to search and being connected with one or more indicators actuated by the changes in E. M. F. of the thermopile, or the changes being due to variations in the radiation of energy to or from the receiver due to the presence of cooler or warmer bodies in its field of view.

2,883. AN IMPROVED APPARATUS FOR USE IN THE COALING OF SHIPS OR LIKE OPERATIONS. J. ROBERTSON, OF 94 WINDSOR ROAD, FOREST GATE, ESSEX.

Apparatus for coaling ships comprises broadly a pontoon having platforms between and to which the barges can be anchored, a vertically adjustable travelling bucket elevator supported by a structure carried by the pontoon adapted to depend into a positioned barge, a chute carried by the elevator and adjustable in position relative to it, means, carried by the adjustable chute being provided for tipping the buckets of the elevator as they pass the chute. Provision is made for holding the buckets in the normal position until they reach the discharging position substantially as specified.